YAMAHA
SHOP GUIDE

TO

THEORY
MAINTENANCE
TROUBLESHOOTING
REPAIR

INTRODUCTION

The Yamaha Shop Guide is designed to furnish dealers and mechanics with a major source of general Yamaha information. It will provide sufficient information to understand and troubleshoot the basic systems on any Yamaha engine.

The shop Guide updates the Blue Service Manual which has become outdated and incomplete due to the many engineering and model design changes of Yamaha sportcycles. The new Shop Guide, however, is more than a revision of the old; because so much new information was available we considered it necessary to research and print an almost entirely new manual.

Information has been gathered from many sources; some from the old Service Manual has been retained, as it is never outdated. Much of the information has come out of Yamaha International's Service Department and, in addition, the fund of service information contributed by our still growing dealer network. In addition, various motorcycle authorities and technical publications have also supplied our staff with valuable contributions.

All this information has been collected within our Shop Guide to make your job faster, more efficient, and to help you develop quality repair methods; all of which will put more profits in your pocket.

HOW TO LOCATE INFORMATION

Each chapter covers basic theory of operation for a given system and follows with the correct methods to check, maintain, and repair that particular system. For example: If you turn to the chapter on Carburetion, you will find that it is broken down into several sections. These sections deal with the principles of carburetion (what makes it work), an illustrated breakdown, and several sections giving the 'how-to' of maintenance, repair, troubleshooting.

The table of contents on the following page gives the page number for the start of each chapter. On the first page of each chapter is an index listing all of the information within that chapter. Just look up the assembly you desire information about and turn to the page indicated.

TABLE OF CONTENTS

YAMAHA

SERVICE MANAGEMENT & PROFIT

SERVICE MANAGEMENT & PROFIT

The best possible advertising media for your Sales Department is your service. Nothing builds future sales as positively as a good running machine. A customer who is happy with the performance of his Yamaha will certainly tell others, and if they keep talking about you, you are sure to sell.

Efficiency is the key note of a successful service department. Furthermore, an experienced mechanic with good equipment can beat the flat rate manual by a considerable margin. The Service Department, therefore, can be not only a credit to itself but also to the entire shop. We shall list some of the ways by which you can streamline your Service Department.

1. Personnel. Every person in the department must be efficient, proud of Yamaha, and loyal to you. To help you achieve this, Yamaha offers you the finest mechanical education in the motorcycle industry. It is then up to you to take advantage of it and to train the necessary personnel to staff your Service Department so as to handle the complete work load which may enter your service door. Recognizing that your business is seasonal, we have instituted an intensified training program to help you handle the summer rush. Our basic course is still the two-week program which is the only complete one offered. Whatever your needs, it is up to you to search for suitable personnel to send to these schooling programs. You can then advantageously advertise the fact that your shop employs factory trained personnel, and this advertising can be done on the side of your building, in the newspaper or on a billboard. Your financial outlay for sending someone to our training program should very very slight, and most people would be happy to avail themselves of such a fine training program which will stand them in good stead the rest of their life. Naturally, this formal training must be well fortified with actual experience. Your most valuable mechanic will be one who can handle any Yamaha job that comes along.

2. Parts Support. The mechanic cannot work without parts and there should be a reasonable availability of all parts necessary for proper repair. Stock your shelves often and well, maintain a close relationship with your Yamaha Parts Department, and if possible, maintain contact with other dealers in your area. Remember that a machine which is tied up while waiting for parts not only brings about customer unhappiness, but also costs you money in terms of floor space not available for other purposes.

3. Shop Appearance. Ask your customers what they think about the appearance of your service department. It must look neat and efficient. When they see your place, they must believe right then and there that you are offering the ultimate in service efficiency. The appearance of your entire building and grounds will also influence his opinion of the efficiency of your Service Department. Try to create the impression that you are organized and systematized, and that you will give his machine the kind of mechanical attention which he thinks it deserves.

4. Equipment. You must have all the basic necessities of the Service Department. You cannot do without bench space, hand tools, special Yamaha tools, as well as the ordinary shop tools such as air, grinders, and vices. Impact tools, hydraulic hoists, crankshaft equipment, and the like should be added as soon as possible. Shops having more than one mechanic should be divided into individual work areas and each one should be as complete as possible. This includes electrical testing equipment and all the other tools that speed up the usual work. Get some sort of steam cleaner or pressure cleaner, if you can, remembering that you do not have to give away this service.

5. Specialization of Duties. Especially if your Service Department employs more than one person, it will be advantageous to systematize the flow of traffic through your Service Department. The area closest to door should be used for cleaning machines, for the lighter work, and generally for the jobs that will not be in the shop as long.

5. continued -
Further on inside, you will have your more competent mechanic and his area which will go into the complete overhaul or the more troublesome machine. A good shop layout must be balanced by the planned capabilities and duties of the personnel available.

6. Accounting System. A financial profit and loss statement can and should be kept on your Service Department. Listed below are the suggested categories which you or your accountant can use for a starter. They are not absolute and may easily be changed to suit individual requirements. Remember that all time spent by the mechanic should be accountable. Please note that not all items are profitable and the classifications such as warranty labor and parts as well as internal parts and labor should be "no profit" items.

SERVICE

Customer Labor	
Gross Income	$ xxx.xx
Cost of Labor	- xxx.xx
	xxx.xx
Warranty Labor	
Gross Income	$ xxx.xx
Cost of Labor	- xxx.xx
	xxx.xx
Internal Labor	
(a) Set-Up	
Gross Income	$ xxx.xx
Cost of Labor	- xxx.xx
	xxx.xx
(b) Demonstrators	
Gross Income	$ xxx.xx
Cost of Labor	- xxx.xx
	$ xxx.xx
(c) Racing	
Gross Income	$ xxx.xx
Cost of Labor	- xxx.xx
	xxx.xx
Sublet Labor	
Gross Income	$ xxx.xx
Cost of Labor	- xxx.xx
	xxx.xx
Others	
(a) Sales Functions (demonstrations, instructions, etc.)	
Gross Income	$ xxx.xx
Cost of Labor	- xxx.xx
	xxx.xx
(b) Shop Maintenance	
Gross Income	$ xxx.xx
Cost of Labor	- xxx.xx
	$ xxx.xx
Total Net Profit	$ xxx.xx

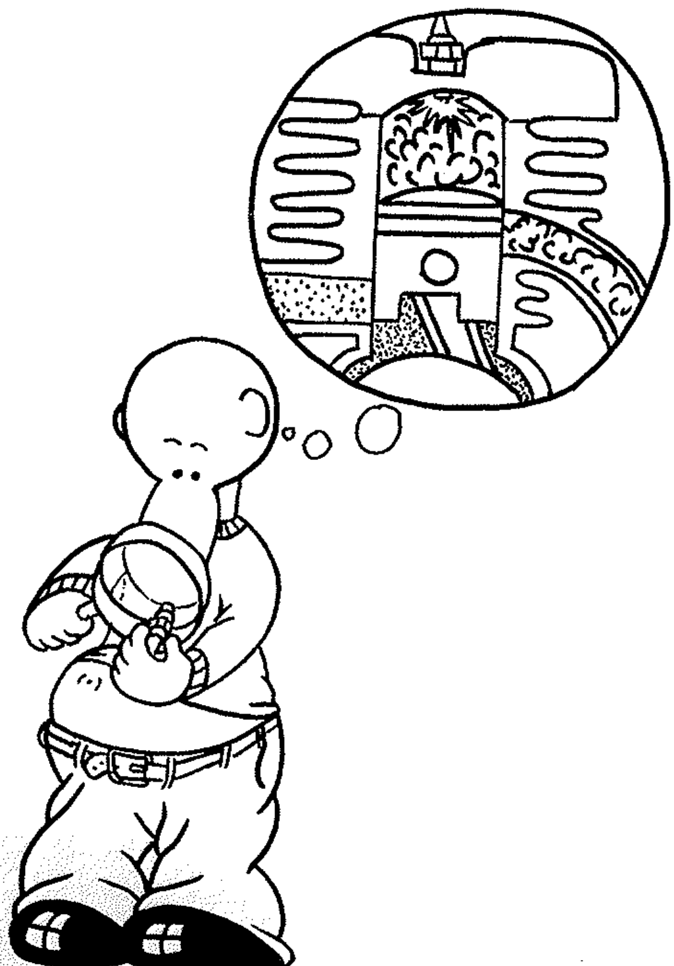
PARTS

Service-Installed Parts	
Gross Income	$ xxx.xx
Cost of Labor	- xxx.xx
	$ xxx.xx
Warranty Parts	
Gross Income	$ xxx.xx
Cost of Labor	- xxx.xx
	$ xxx.xx
Internal Parts	
(a) Demonstrators	
Gross Income	$ xxx.xx
Cost of Labor	- xxx.xx
	$ xxx.xx
(b) Racing	
Gross Income	$ xxx.xx
Cost of Labor	- xxx.xx
	$ xxx.xx
Counter Retail Parts	
Gross Income	$ xxx.xx
Cost of Labor	- xxx.xx
	$ xxx.xx
Counter Wholesale Parts	
Gross Income	$ xxx.xx
Cost of Labor	- xxx.xx
	$ xxx.xx
Accessories	
Gross Income	$ xxx.xx
Cost of Labor	- xxx.xx
	$ xxx.xx
Total Net Profit	$ xxx.xx

7. Planning Ahead. We now have the ammunition to be able to handle any service situation. The service efficiency you have to offer should be 100% and you must then put it to work in a way that will please your customers and yourself. It will be up to you to run constant checks on the efficiency of your Service Department, and then correct whatever areas are weak. Check with your customers and you will find that they can give you helpful suggestions concerning what they want and will advertise to others. Your service program will not only be profitable in itself, but while it is improving, you will find a corresponding improvement in sales.

YAMAHA

SPARK PLUG



SPARK PLUG

SPARK PLUG

INTRODUCTION

The basic principle of a gasoline engine is to convert heat energy into mechanical energy. In order to first obtain the heat energy, it is necessary to have an enclosed container (combustion chamber), a burnable mixture (compressed gas and air in the proper ratio), and a means to ignite the mixture. The spark plug's function is to ignite the mixture in the combustion chamber. The plug has to be designed to consistantly deliver the full 7,000 - 10,000 volts that is developed by the ignition coil. The efficiency of the engine is dependent on the efficiency of the spark plug.

Naturally one specific type of spark plug cannot be used in all types of vehicles because of the diversified demands and usages of individual machines. Two people may own the same model motorcycle, but one owner may want a low RPM trail type cycle, while the other may want to use the bike strictly for highway travel. The two identical cycles will be subjected to completely different conditions. These conditions will naturally determine the type of spark plug adequate for the use intended.

FUNCTION

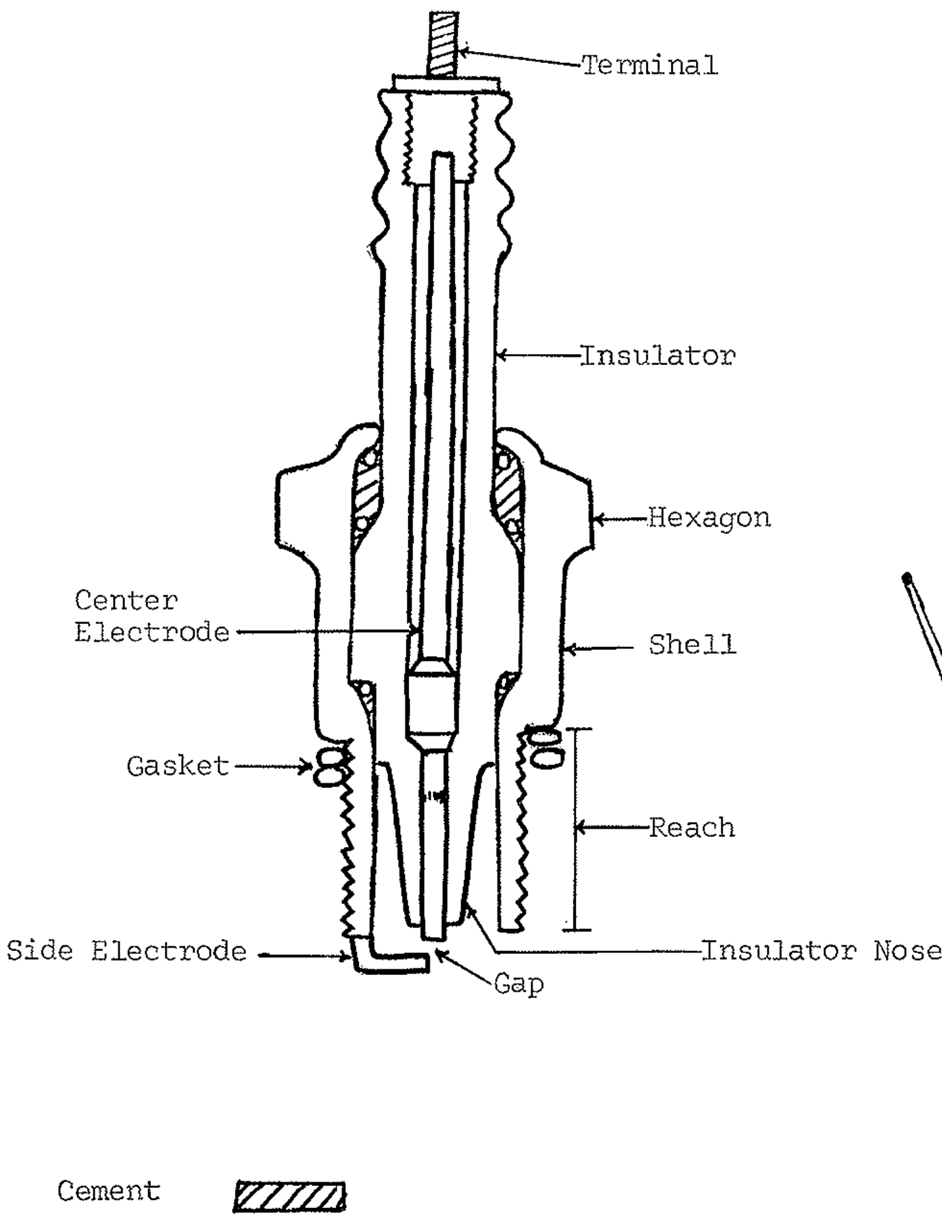
The primary purpose of a spark plug is to ignite the compressed gas-air mixture contained in the combustion chamber, converting it to energy. Considering all other parts of the engine to be operating satisfactorily, the condition of the spark plug will determine how efficiently the engine will operate. The spark plug has to provide a healthy spark from low RPM to full throttle, and operate under varied and adverse conditions (high compression and 50-150 sparks-per-second at high RPM) that will attempt to suppress the spark plug's functions.

A secondary function of the spark plug is to act as a path for combustion heat to escape. Great amounts of heat are produced in an engine, and it is necessary to draw off as much heat as possible as a safeguard against engine failure due to heat. As long as it is required that a spark plug be present in the combustion area, it would be wasteful to not make use of its presence in as many ways as possible.

Heat drawn off by the spark plug is transferred through the gasket to the plug seat area, and out the threads to the head. In this manner heat is not retained in the spark plug, thus avoiding structural breakdown and eventual spark plug failure.

SPARK PLUG COMPONENTS

To prevent any later confusion, first consider all the parts of a spark plug. As you can see from the following diagram, all the major parts are labelled. We will later go into a description and the difference of each.



INDIVIDUAL PARTS

Insulator

Primarily, the insulator prevents electrical leakage from the center electrode to the spark plug shell, or any metal situated close to the spark plug. Secondary voltage is forced to follow the center electrode down to, and across, the electrode gap to get to a ground.

The insulator also absorbs approximately 20-25% of the total heat soaked up by spark plug. Heat travels up the insulator to the point of insulator contact with the metal shell. The heat then flows to the head and is dissipated into the air.

Enough heat is retained by the insulator to burn off gas and oil deposits, keeping the spark plug clean. This is referred to as its 'self-cleaning' quality.

Quality of the insulator material is of prime importance also. It has to be capable of withstanding severe temperature changes within short periods of time. It also has to withstand continuous vibrations from combustion. An inferior quality insulator will crack from the sudden temperature changes and shocks.

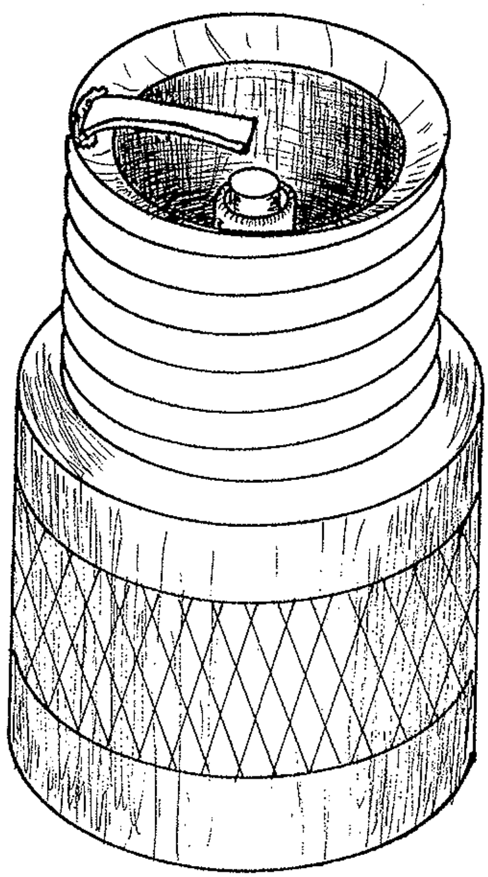
Electrode

The electrodes act as two metal electrical conductors spaced a measured distance apart to provide a place for the spark to be created for ignition.

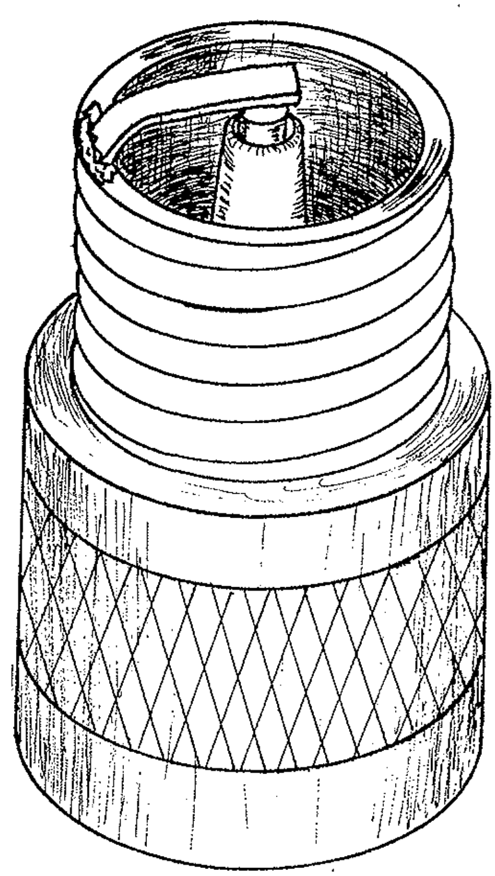
Because of its location in the combustion chamber, the electrodes must be built to withstand heat and electrical erosion.

Electrode (continued)

Spark plug electrodes for two-strokes are designed somewhat differently to be better adapted for use under difficult conditions. The center electrode, depending on the manufacturer's design, is sometimes recessed slightly, and the side electrode only projects partially over the center electrode. The differences of the two types of plugs are shown below. These variations are to protect the electrodes from collecting unnecessary deposits that are caused in two-strokes by oil, gas, and exceptionally high operating temperatures. The possibility of electrode bridging is greatly reduced.



2 -STROKE SPARK PLUG



STANDARD SPARK PLUG

Spark Plug Shell

The metal spark plug shell acts as a container to hold the spark plug components solidly in place, to act as a passage for heat to travel to the head for dispersion, and as a ground contact for the side electrode.

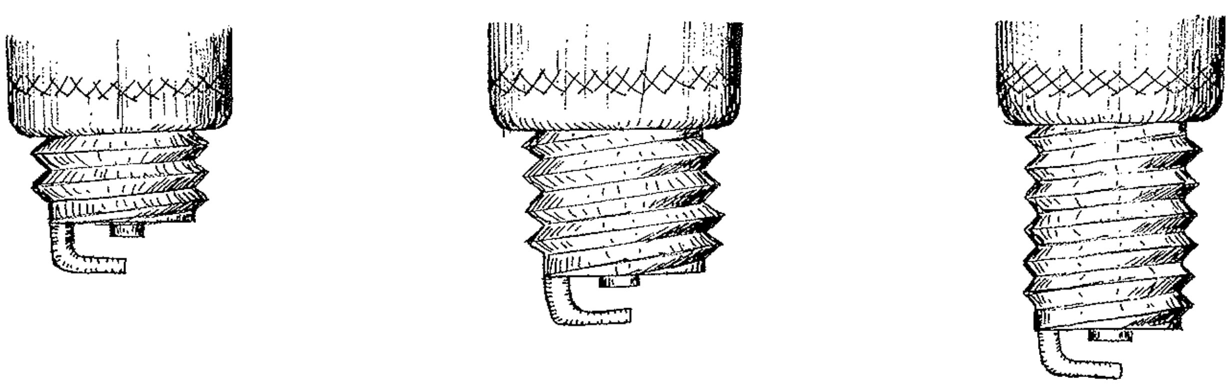
Spark Plug Threads

Spark plug threads act to firmly anchor the spark plug in the head. Thread diameters for most motorcycles come in 10mm, 14mm, and 18mm sizes. This is to accommodate the various manufacturer's designs. Yamaha engines use 14mm threaded spark plugs only.

Thread Reach

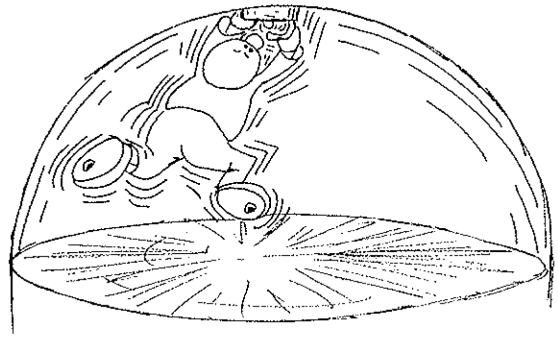
Another manufacturer's variation is the thread reach. Reach is the length of threads from seat to spark plug nose. The reach length of motorcycle plugs is standardized to three lengths, 3/8" (not used in Yamahas), 1/2" (denoted by an "H"), and 3/4" (denoted by an "E").

3/8" 1/2"(H) 3/4"(E)



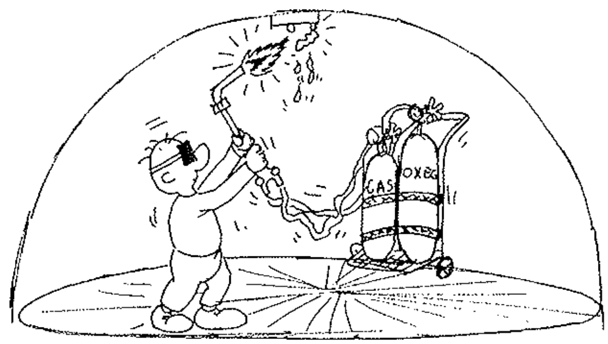
Thread Reach (continued)

It is very important that the correct reach is used in any particular motorcycle as per factory specifications. The consequences of using the wrong reach plug could be serious. Consider the possibility of a 1/2" reach plug in a head requiring a 3/4" reach. The plug is no longer able to reach the combustion chamber. This acts to retard the ignition timing because the spark has a farther distance to travel, taking a longer time. Loss of power and overheating are the results. Also the threads in the head are exposed to carbon build up so that when an attempt is made to install the correct length plug, it will not go because of deposits on the bottom threads. If a 3/4" reach plug is used where a 1/2" plug is needed, serious trouble can be the result. The plug will now extend into the combustion chamber and be closer to the piston crown. Ignition timing will now be advanced and spark plug overheating will occur. There is a good chance of pre-ignition or detonation occurring. This will cause overheating of the piston crown and piston failure. If conditions are such that piston failure did not occur, then there would be problems with the deposits which have formed in the plug's exposed thread surfaces. These will make removal and replacement difficult, possibly causing cylinder head threads to strip out.

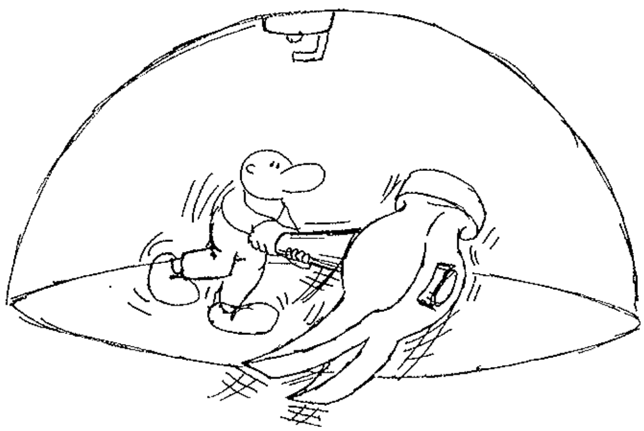


Vibration

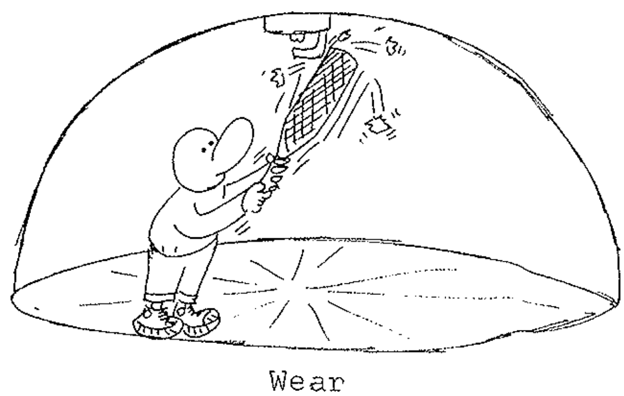
Deposits



Heat



Pressure



Wear

A spark plug must work under a variety of engine conditions. The most important are listed below:

Heat: under normal operating conditions there is about an 800°- 1200° operating temperature present at combustion. Should the engine run hard under extreme load and RPM, there could be a temperature rise up to 1700°. Heat is usually the greatest single cause of spark plug deterioration. The heat attacks the exposed electrode and little by little burns it away.

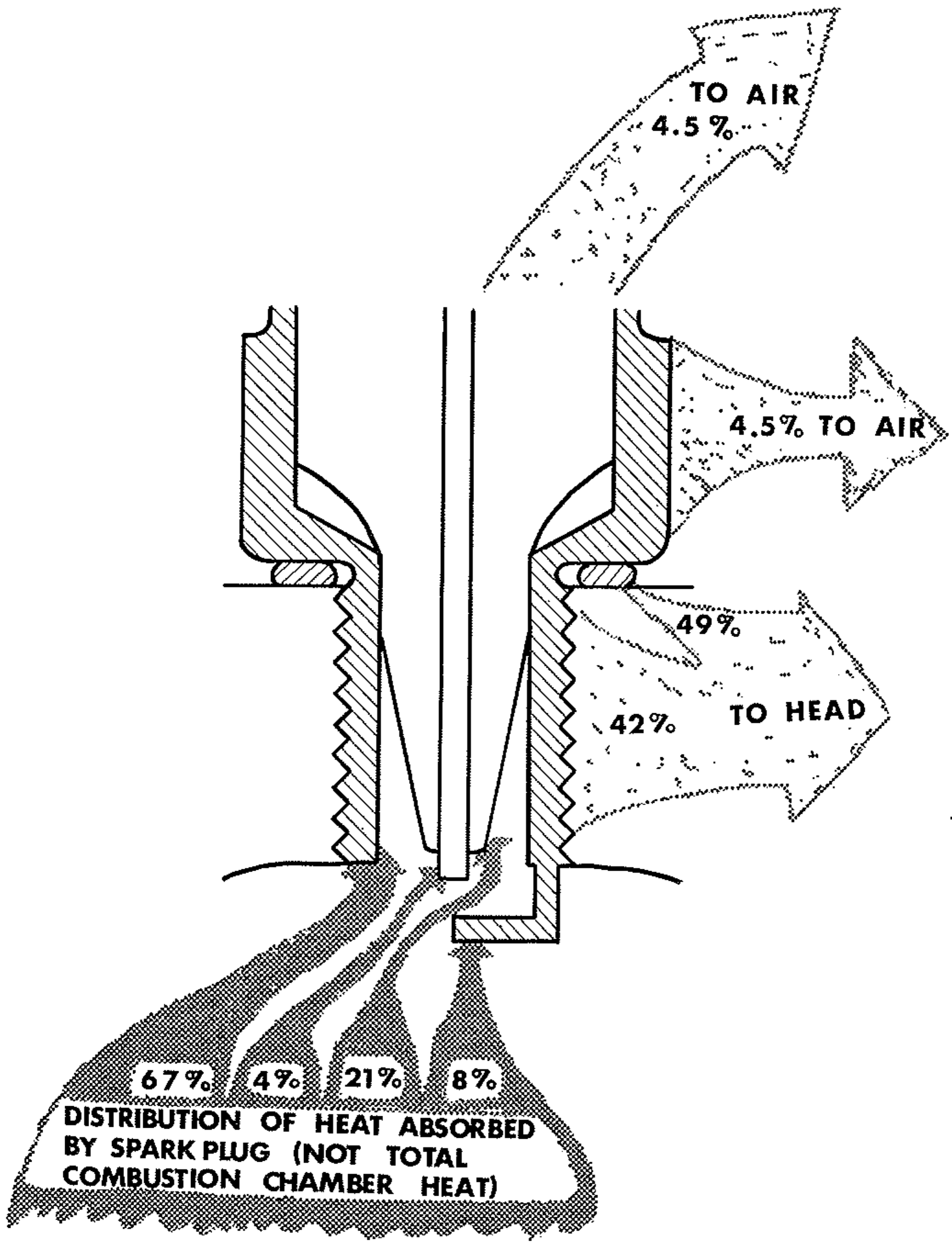
Pressure: another condition affecting the life of the spark plug. When an engine is running at 3,000 RPM, it is generating 3,000 explosions per minute. This means that the plug is subjected to nearly a 1/4 ton of pressure, 50 times a second.

Deposits: also a detrimental condition, are formed in the combustion chamber as a result of ignition. They come from gasoline, dirt and oil. They settle on all the exposed surfaces of a combustion chamber, including the spark plug. Some of these deposits are acids and they help eat away the exposed side electrode. Other deposits of carbon, sulphur, lead, nickel, and phosphorous form on the side and center electrodes as will as the insulator tip and cause erratic sparking, shorting, fouling, tracking, and bridging.

Vibration: another problem associated with two-cycle engines. At very high RPMs, vibration becomes quite intense and after a few miles can effect spark plug operation.

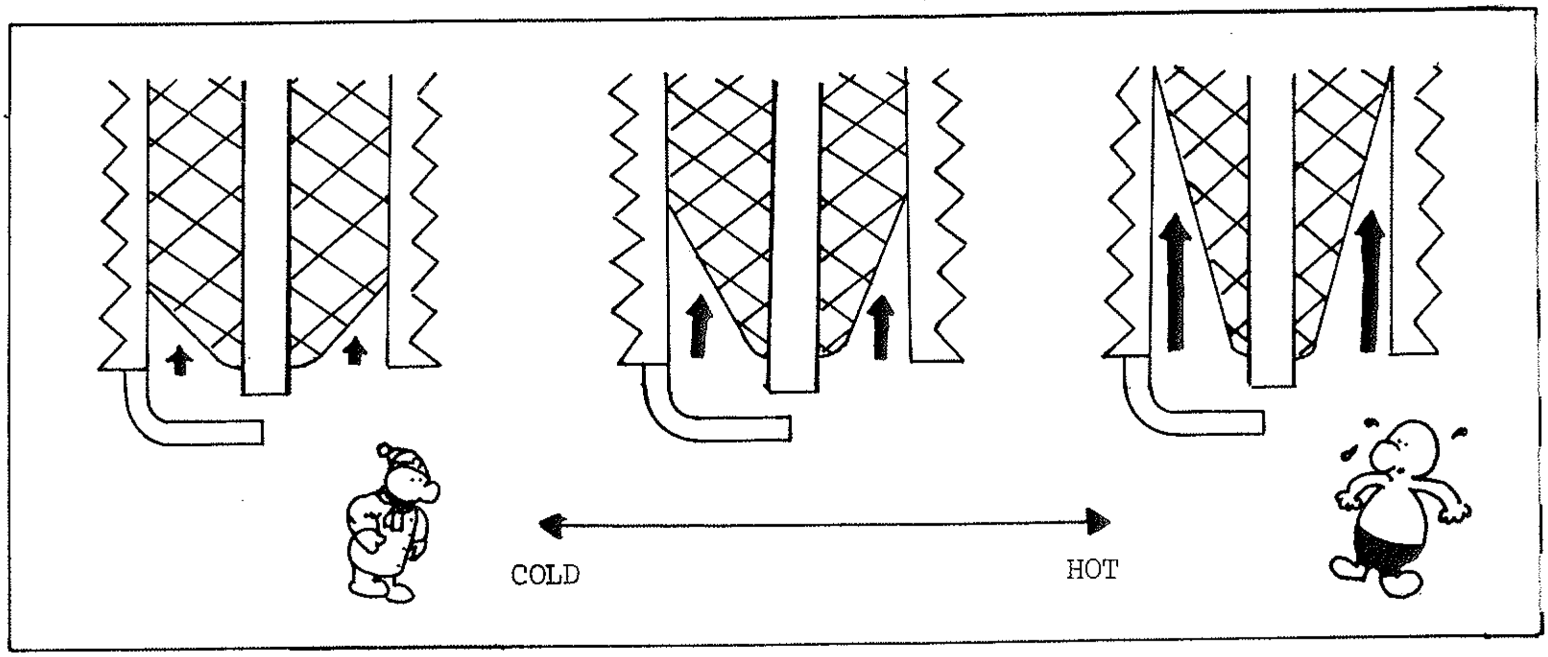
HEAT DISSIPATION

It is necessary to determine the direction and percentage of heat through a spark plug in order to design spark plugs with different ranges of heat dissipation. The illustration gives an accurate picture of heat absorption and dissipation, and the percentage involved, through each spark plug component. (Information courtesy of Champion Spark Plugs)

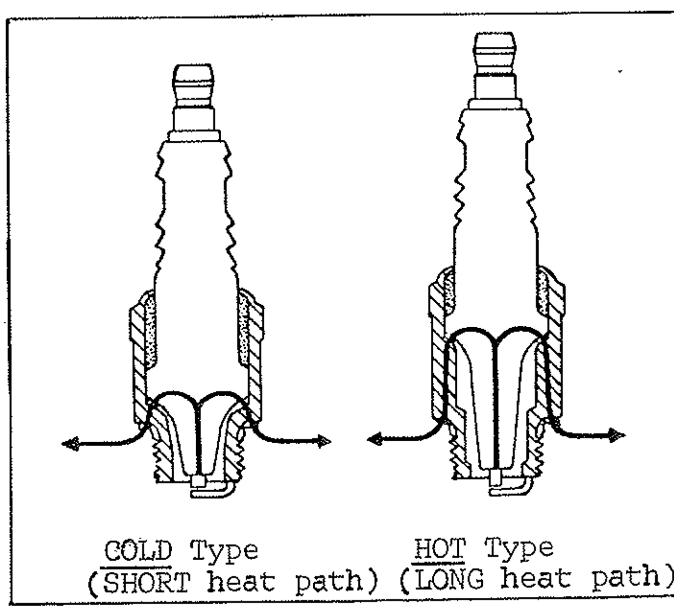


HEAT RANGE

"Heat range" is the term of a method applied to classify spark plugs according to their ability to transfer combustion heat as it is absorbed at the insulator tip and passed to the head (main cooling surface). Heat must follow a particular path to get to the cooling surface of the head--up the length of the insulator to a point of contact with the metal shell. The shell is in contact with the head.



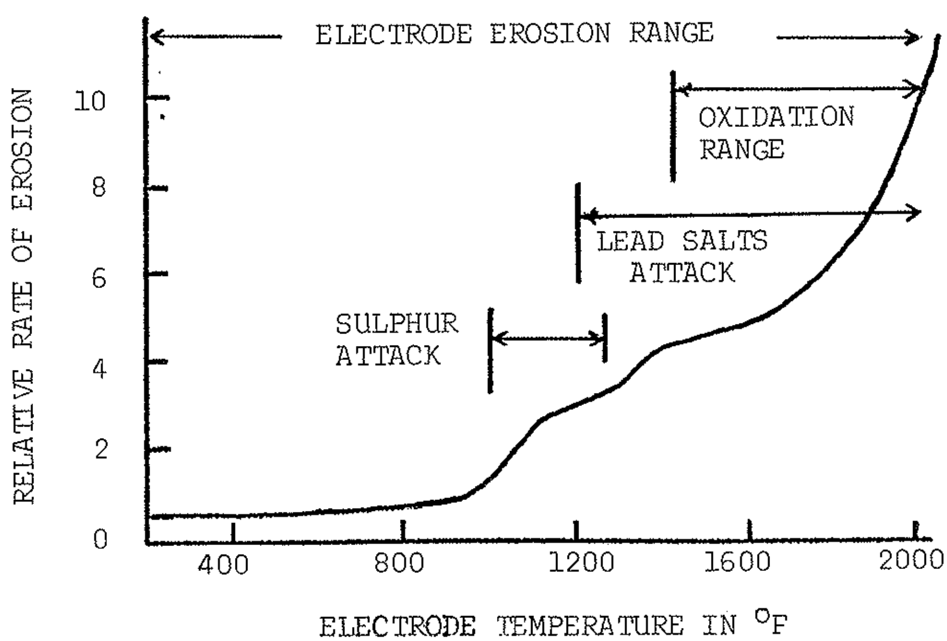
The heat range of a spark plug is determined by the length of the insulator, from its tip to the point of shell contact (length of insulator nose). A cold plug has a short heat path from tip to shell, allowing heat to rapidly escape to the head and to air. A hot plug has a long insulator nose and heat cannnot escape as quickly, thereby retaining much more heat. The spark plug continually remains hotter, having less chance to cool off before the next combustion stroke. This is the basis for a variety of spark plug heat ranges. The variety of heat ranges accommodate various type motorcycle engines, and their heat generating capacities.



A motorcycle that is constantly run at low RPM, and with a light load, will not develop very high operating temperatures. In this instance it would be advisable to use a "hot" spark plug, one with a long insulator nose, in order to retain enough heat in the insulator to burn off gasoline and oil deposits that might otherwise form on the insulator. This is extraordinarily true when considering two-strokes and their susceptability to deposit formation. Conversely, a motorcycle that is intended to 'burn up the road' will develop high operating temperatures caused by high RPM. One of the colder plugs would be advisable for this bike in order to safely handle the extra heat. A plug that cannot transfer a sufficient amount of heat eventually disintegrates from the high temperatures. Another noticeable affect from a spark plug that is too hot is pre-ignition caused by the plug surface igniting the mixture before the normal ignition spark.

The purpose then is to have a spark plug heat range selection that will furnish a spark plug that will retain enough heat to protect itself from unwanted deposits, but still is able to handle higher temperatures within a certain range without breaking down.

Heat is the greatest enemy of spark plug life. This is easily seen by using the chart shown below and comparing the rate of electrode erosion to the continuous rise in temperature. This graph also shows why an attempt is made to keep the temperature of the plug insulator and electrode just hot enough to burn away oil residues (including sulphur) and not hot enough to allow lead salts (from oil and gas) and oxidation to damage the insulator and electrode.



(COURTESY OF CHAMPION SPARK PLUG COMPANY)

SPARK PLUG READING

A general rule to follow when initially choosing a spark plug for a specific model motorcycle is to go by the manufacturer's recommendation. However, after using the spark plug for a short time, it might be discovered that the spark plug's heat range is not correct for the motorcycle's usage. A spark plug being a heat range step hotter or colder might be necessary. There is a definite procedure to follow to determine the effectiveness of the spark plug. This procedure is called a "spark plug reading". A spark plug reading is taken by observing the coloration and condition of the insulator after sufficient engine use has been allowed to affect it.

In order to obtain an accurate spark plug reading, it is necessary to run the motorcycle at normal operating speed, under actual load, for approximately 3 - 5 minutes. Shut the engine off, close the throttle, clutch the engine, shift it into neutral, and bring the cycle to a halt. Remove the plug (or plugs) and carefully note the color and condition. Provided that the motorcycle engine is in mechanically good condition, the carburetor is functioning correctly, good gas is being used, the oil-to-gas ratio is correct, and the ignition system is operating efficiently, then the only condition to effect the spark plug is its heat range.

A spark plug with the correct heat range will show a light tan color on the insulator nose. This indicates that the spark plug is retaining the correct amount of heat to burn off unwanted deposits, but not enough to do any damage.

A spark plug that is too 'cold' will not retain sufficient heat to cause complete cleaning of the insulator and electrode tip, and this will be indicated by noticing a layer of mixed unburned residue such as gummy oil deposits and/or black fluffy carbon deposits. The coloration of the insulator will vary from very dark brown to black.

A plug that is too 'hot' will be opposite in appearance to the cold plug. Too much heat will be retained by the longer insulator, and not only will all deposits be burned off, but very possibly the insulator and electrode will begin to melt from the heat. Visual proof of excessive heat will be a white appearance, possibly shiny. Extreme heat will also be indicated by small pimples or bumps on the insulator near the tip. These may be gray, white, or any shade of blue, green or purple. Also check the very tip for heat distortion and actual melting, since it is the hottest point. Naturally the electrode will also burn because of its location, so an increased electrode gap in a very short time will also be an indication of heat. Normal electrode wear is limited to roughly .001" of gap increase per thousand miles.

When making any heat range changes to correct a plug reading, it is recommended that the plugs be replaced one heat range step at a time, either hotter or colder. For an example, consider that the motorcycle in question is using an NGK B-8HC spark plug. If insulator appearances are not satisfactory, go either one step colder to a B-9H, or one step hotter to a B-7HZ, always trying to get the light tan color. Once a change of spark plugs has been made, make an identical spark plug check as was previously described.

The incoming fuel/air mixture from the carburetor can deviate from the proper ratio at different throttle settings due to possible misadjustments in the carburetor itself. Should this mixture be incorrect, the average temperature in the combustion chamber will vary accordingly. It is sometimes necessary, therefore, to run spark plug checks at throttle settings other than the average in order to check the various mixture control settings on the carburetor.

For example: a performance complaint may indicate an incorrect needle setting in the carburetor mixing chamber. It would be advisable to mark a ½ throttle position on the handle bar grip and run the machine in 4th or 5th gear for several minutes at exactly ½ throttle and then take a plug reading. This procedure should be repeated at any other throttle opening where performance indicates a possible carburetor misadjustment. (See the section on Carburetion for details).

Remember: the spark plug is an indicator of average temperatures within the combustion chamber and can be used as a most effective troubleshooting aid when basic engine theory is completely understood. Also use a magnifying glass for diagnosis, if possible, remembering that this helpful tool is one indication of a true specialist since it allows him to see the conditions mentioned.

MAINTENANCE

Spark plugs require regular maintenance to keep them functioning at maximum efficiency. This is true for spark plugs even being operated under ideal operating conditions of a two-stroke engine. Two-stroke engines contain much more contaminants in their combustion chamber than four-strokes, thereby demanding more frequent cleaning.

Any time that a spark plug is being removed from an engine and quite a bit of dirt covers the engine, it is best to first use compressed air to blow off the area around the spark plug. Any dirt that is laying near the spark plug that could possibly fall into the combustion chamber when the spark plug is removed, is blown away.

Next, the plug is removed and analyzed as to whether it is still good or not. Replace it if the spark plug is faulty. A plug can effectively be cleaned if its only problem is oil or gas fouling. The best way to clean a plug of this type is to thoroughly wash it in a solvent such as acetone or carbon tetrachloride. Then air-blow the plug as the final step. Any plug that has been in use long enough to collect deposits on the insulator and electrodes should really not be considered for reuse, even if it is cleaned with a sand-air blast cleaner. There is a definite reason for not using the sand blast cleaner. Spark plugs have a shiny insulator surface. If a plug is sand blasted, this surface is roughened and it is possible that the heat range of the plug could be affected. This is a special consideration with 2-stroke engines because of their critical heat factor. Naturally though, if the spark plug fails, and no new plug is available at the time, any reasonable method used to clean the plug is fine until a new spark plug is available. Even the point of a knife or a thin wire can be used to remove deposits or anything fouling the plug. Another consideration when questioning the quality of a spark plug is that in 2-strokes, spark plug life is short. The national average life of a plug is 800 miles in a small bike and 1200 miles in a large bike. Naturally there are exceptions, but consider that the plugs can easily fail with only a few miles on it if the engine is lugged as in city driving. Replace those plugs that are definitely sub-standard.

(Note: Never attempt to clean a plug, even one that is gas fouled, by bringing an open flame into contact with the spark plug insulator and electrodes. This direct heat will definitely harm the plug.)

After the plug has been cleaned, correctly regap the electrodes to factory specifications. The plug is now ready to be reinstalled in the engine.

It is recommended that whenever available, use a new gasket. Also it is suggested that perhaps some liquid graphite be applied to the plug threads to aid in ease of plug installation. This will help maintain sharp threads in the head, which is beneficial, considering that aluminum threads can very quickly wear out.

Screw the plug in by hand until the gasket contacts the head seat. Then use a torque wrench and tighten to factory specifications as listed below.

Thread size	Torque	Torque
10mm	1.1 - 1.5kg/m	8-11 Ft-Lbs
12mm	2.1 - 2.6kg/m	15-19 Ft-Lbs
14mm	3.0 - 3.5kg/m	22-25 Ft-Lbs

If a torque wrench is not available and the spark plug being installed has a new gasket, then screw the plug in until the gasket touches the head seat and use a spark plug wrench to continue tightening the spark plug an additional 1/2 - 3/4 turn. This will sufficiently compress the new gasket to adequately act as a seal.

A faulty spark plug is the greatest single reason for a motorcycle not starting. Many people do not realize this. Periodic spark plug maintenance is a necessity if a motorcycle is expected to function efficiently and continuously. The importance of good spark plug condition cannot be too greatly stressed.

It is recommended that if a single machine is at times subjected to different kinds of operating conditions which require 2 different heat ranges of spark plugs, then both types should be carried on the machine and inserted to match the anticipated extreme use. This will result in minimum total cost and problems.

TROUBLESHOOTING

There are many motorcycle troubles that can effect the spark plug's efficiency. This should be taken into account whenever an engine suffers from persistantly erratic plug readings. It is best, and most efficient, to make a specific and logical check of any part of the engine susceptible to failure. The following areas should definitely be checked as they greatly effect what happens in the combustion chamber, and consequently the spark plug.

Spark plug: Recheck the manufacturer's specifications for proper heat range and reach.

Sealing: Make sure that the spark plug always has a gasket and is torqued down properly. A loose plug allows air to be sucked into the combustion chamber, causing a very lean mixture to exist. The lean mixture creats abnormal heat.

Cooling: Check to make sure that the cooling areas are clean and the fins are unplugged.

Head: Make sure the head is properly tightened down to avoid an air leak.

Compression: Make a cylinder compression test to check how effectively the rings are sealing. Also, when making this test, take into consideration that if the machine has been operated a long time without decarbonization, the carbon build up can be great enough to cause a noticeable rise in the compression reading. This occurs because carbon build up reduces the combustion chamber area, which in turn increases the compression ratio. Naturally, higher combustion chamber temperatures will also develop because of (1) the insulating quality of the carbon, and (2) the increased compression ratio.

Electrical: Check to make sure the points are clean and gapped correctly. Also test to see that the coil is putting out a healthy spark. Another very important check is for correct timing on both cylinders (if applicable). If the timing is retarded on one cylinder, the other will overheat trying to do the work of both cylinders. The spark plug will again show the results of this extra heat.

Carburetion: Check the idle adjustment for correct mixture. Also check for correct float level, needle setting, needle jet size, main jet size and idle jet size. It is possible that the jets are the correct size but are plugged up. There is a possibility that the carburetor is not securely tightened to the mounting flange, causing another spot for a lean mixture to develop.

Autolube: Check the autolube to insure that a proper quantity of oil is being sent to the engine. Too much oil could falsely read as a too rich fuel mixture.

Rider habits: A new motorcycle that is run too hard will readily overheat until it is broken in. Just the opposite is also true if a rider "babies" it during the break-in miles. A new cycle has a tendency to load up when lugged. A hotter plug might be needed until the engine is broken in and then replaced with a colder plug. This suggestion is only applicable as a temporary aid for the rider who insists on riding the Yamaha at low RPM because he is unaccustomed to a high revving 2-stroke.

If the rider is constantly riding his bike at low RPM, then just continually replacing the spark plugs will not cure his problem. The rider is definitely going to have to change his habits and run the cycle in the RPM range that best suits the engine's capability. Lugging an engine leads to continual spark plug breakdown and early engine troubles.

General overhaul time: The 2-stroke engine needs to be decarbonized approximately every 2,000 - 3,000 miles. If this maintenance is neglected, then generally poor engine conditions will continuously effect the spark plug. Carbon build up in the combustion chamber causes the engine to run considerably hotter than normal. The spark plug will naturally show the hot symptoms. Always question the motorcycle owner as to the date of the last decarbonization.

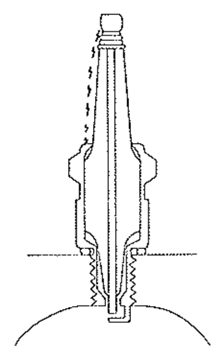
There are also several miscellaneous spark plug readings that do not appear to be normal.

Spark Plug Appearance	Abnormal Engine Condition
Bridging	Dirt sucked into the combustion chamber through a poorly filtering air cleaner (or no cleaner at all) will very readily become stuck to the electrodes, eventually shorting them out.
Metal deposits on electrodes	This is evidence that combustion chamber temperatures have become high enough to melt the piston to some degree. Always pull the head to check the extent of damage.
Grain-like deposits on the insulator . . .	This too could be dirt sucked in. The most common cause for these substances is a radically high temperature causing gasoline deposits to form.

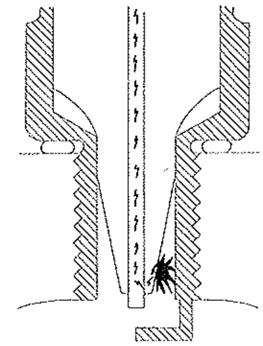
Note: It is important to note that many unusual spark plug readings that suddenly pop up are directly connected to poor quality gasoline. Gasoline that has been allowed to set a month or more will start to break down. Also gasoline companies sometimes raise the octane level of gas by adding quantities of lead additives (anti-knock compounds). If a rider brings his bike in complaining of sudden and unexplainable deposits on his spark plugs, suspect the gasoline that he is using. This can be checked by having the rider change his brand of gasoline for a short time, then take another spark plug check. The deposits will cause discoloring of the insulator as well as possibly leaving actual hard deposits.

This problem with bad gas is more prevalent than first thought. Motorcycle owners should be recommended to buy their gasoline at high volume dealers who sell quality gas. This cuts down the possibility of constantly getting poor gasoline.

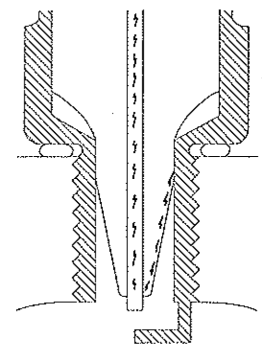
A series of illustrations are shown as an aid in understanding the malfunctions that can occur at the spark plug. These illustrations graphically depict the trouble when a spark plug seems to be failing in its designed functions, either firing poorly or not at all.



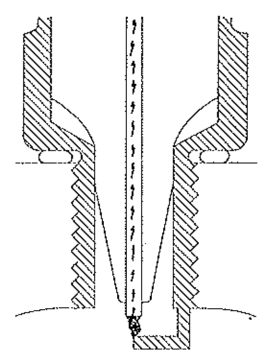
Flashover: Dirt, oil, water, and other substances might build up on the exterior surface of the porcelain. When this occurs, it provides a path of much less resistance than that of the electrode air gap. The spark travels along the outside of the spark plug to 'ground', completely bypassing the electrode air gap. Thoroughly cleaning the spark plug in solvent eliminates this problem.



Tracking: A build up of deposits on the insulator redirects the spark up the insulator and the spark fires late, somewhere along the lumps of deposits. Ignition isn't suppressed completely but the timing is retarded sufficiently to cause an unsuspected power loss.



Fouled: This occurs when a build up of deposits is great enough to provide a path for the spark to run along the insulator surface all the way to the metal shell without creating ignition.



Bridged Gap: Deposits can bridge the electrode gap, providing a path for voltage to travel to 'ground' without ever sparking.

THREAD SIZE	HEAT RANGE	NGK STANDARD TYPE	NGK PROJECTED TYPE	CHAMPION Y=Projected Type	A C S=Projected Type	AUTO-LITE	BOSCH	KLG P=Projected Type	LODGE Y=Projected Type
18MM Reach ½"	Hot			D23	C88	BT10			
				D21	C87	BT9	M45T1		3BL
		A-6		D16, UD16	C86, TC86	BT8, BZ8	M95T5, M95T2	M30, M30H	BBL, SC
				D14, K15J	C85, TC85	BT6	M145T1, M145T5	M50	C1, C3
				D10	C83, TC83	BT4		M60, M60H	CV
				UK10					
		A-7		D9, D9J	C82	BT3	M175T1	M80	NH18, HH1
				D-6, K-9	C81	BT2	M225T1	M100	
	Cold	A-8		UK-7					
18MM Taper Seat	Hot	A-4F	AP-4F	870, F14Y	86T, 85T, 85TS	BTF6, BF7, BF82	MA95T1	MT30, MT50	CTNY
		A-6F	AP-6F	860, F9Y, F11Y	84T, C84T, 84TS	BTF42, BF42	MA145T1	TMT50	CTN18
				UF11Y		BTF3, BTF31			
		A-7F		F10	C83T				HTN18
				F82		BTF1, BF32			
		A-8F		F62R, F62Y		BF703, BF22			
	Cold	A-9F		F60R, F60Y		BF601			
14MM Reach ⅜"	Hot			J14J, J14Y, UJ18Y	C49, 46S	A82	W45T3		BAN
		B-4	BP-4	J12J, UJ12	48, C47, C47W, M47	A11, AT10, AZ9		FS20	CAN, CCAN
				J11, J11J	46, C46, M46	A9, AT8, A9XM	W145T3	FS30, FS45P	CANY
				J13Y, UJ12Y, J11Y	45, C45, C45W, M45, 45S	A7, AT6, A42		FS50, FS55P	
		B-6	BP-6	J10Y, J8, J8J	44, C44, M44, M44B, 44S	AT4	W175T3	FS70	HAN
				J7, J7J, UJ8					
		B-7		J6, UJ6, J6J	43, C42-4, C43, 43S	A3, AT3	W225T3	FS75	2HAN
					M44C, M43				
		B-7C*							
		B-77C*		J62R		A23			
		B-8		J4, J4J, J61Y, J60R	42, C42-1, M42	AT2	W240T3	FS100	3HAN
		B-9		J2J, J57R	41	AT1			
	Cold	B-10		J54R		A901			
14MM Reach 7/16"	Hot			H12	47L	AL11			
		B-4L		H11	45L, C45L, TC45L	AL9, ATL8			BSN
				H10, H10J, H18Y		AL7, A7	W125T4	FA50, FA50H	CSN
		B-6L		H8, H88, H8J	43L, C43L, C43LY	ATL4, ATL3	W225T3	FA70	
	Cold			H14Y					
14MM Reach ½"	Hot	B-4H	BP-4H	L14, UL15Y, L10	46FF, 46FFS, 45FFS, 45FF	AE52, AE6	W95T1, W145T1	F20, F50	B14, BN, CNY, CN
				L90, UL12Y	45F, 45FD			F55P	CC14
		B-6H	BP-6H	L86, L85, L95Y, L87Y	44FFS, 44FF	AE4, AE42	W175T1, W175T7	F70, F65P	
		B-7H	BP-7H	L7	44F	AE3	W200T7, W200T35	F75	HN, H14
		B-7HC*		L81, L82Y	43F, 42F, 42FF	AE2, AE22	W225T35		HH14
		B-7HZ		L5			W225T1, W225T7	F80	2HN
		B-77HC*		L62R			W240T1, W240T16		
		B-8H		L4J			W260T1	F100	3HN
		B-8HC*		L60R		AE903	W270T16		
		B-9H							
		B-9HC		L57R		AE603	W310T16		
	Cold	B-10H		L54R					
14MM Reach ¾"	Hot	B-4E	BP-4E	N21, N16Y	47XL	AG9	W95T2, W125T2	FE20	BLN, BL14
				N18	46XLS	AG7, AG52		FE30	CLNY
				N8, N84, N14Y	46N, 46XL	AG5	W145T2	FE50, FE45P	CLNH, CC14
		B-6E	BP-6E	N6, N12Y, UN12Y	45N, 45XL, C45XL,	AG4, AG42	W160T2, W175T2	FE70, FE55P	HLNY
				N11Y	44N, 44XL, 45XLS		W200T27, W200T30	FE75	HBLN
		B-7E, B-7ES	BP-7E	N5, N10Y, N9Y	44XLS	AG3, AG32	W225T2, W225T28	FE80, FE65P	HLN
		B-7EC*		N4	43N, 43XL, C42N	AG2, AG23	W240T2, W240T17	FE100	2HLN
		B-77EC*		N3, N62R, N6Y			W250P21, W260T20	FE220	
		B-8E, B-8ES		N60R	42XL		W270T17, W280T2	FE250	HLNP, 3HLN
		B-9E		N57R					
	Cold	B-10E		N54R					

*Competition Types (Shorter Side Electrode)

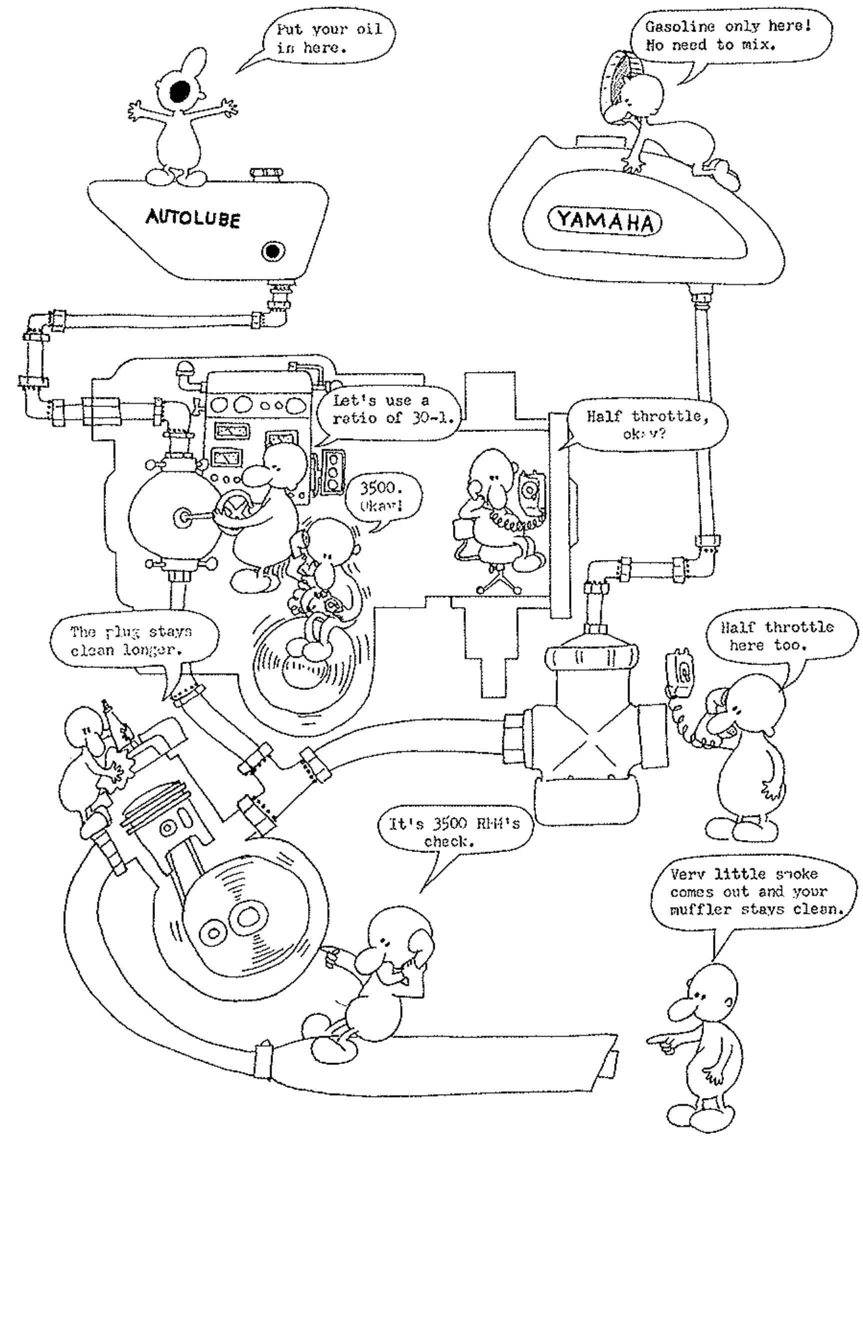
RACING SPARK PLUGS

THREAD SIZE	GAP	HEAT RANGE	NGK	CHAMPION	AUTO-LITE	BOSCH	KLG	LODGE
14MM Reach ⅜"	0.5mm +0.00 −0.05	Hot	B- 8N	J62R, J60R	A903		F260 (With spacer)	R47 (With spacer)
			B- 9N	J57R	A603		F280 (")	R49 (")
			B-10N	J54R	A403		F300 (")	R51 (")
			B-11N		A203		F320 (")	R52 (")
		Cold	B-12N				F340 (")	R53 (")
14MM Reach ½"	0.5mm +0.00 −0.05	Hot	B- 8HN	L62R, L60R	AE903	W310T16	F260	R47
			B- 9HN	L57R	AE603	W340T16	F280	R49
			B-10HN	L54R	AE403	W370T16	F300	R51
			B-11HN		AE203	W400T16	F320	R52
		Cold	B-12HN			W440T16	F340	R53
14MM Reach ¾"	0.5mm +0.00 −0.05	Hot	B- 8EN	N62R, N60R	AG903	W310T17	FE260	RL47
			B- 9EN	N57R	AG603	W340T17	FE280	RL49
			B-10EN	N54R	AG403	W370T17	FE300	RL51
			B-11EN		AG203	W400T17	FE320	RL52
		Cold	B-12EN	N52R	AG103	W440T17	FE340	RL53

NOTE: This chart is furnished as a guide. Due to differences in design and materials, plugs produced by various manufacturers do not have exactly the same heat range.

YAMAHA

AUTOLUBE SYSTEM



AUTOLUBE

WHAT IS YAMAHA AUTOLUBE?

The engineering challenge in the development of the Autolube system lay in two facts. First, the delivery of the oil to the engine had to be variable in relationship to both engine speed and power thrust (throttle opening). Second, the volume of oil handled by the metering device was so small that the mechanical processes involved both in the manufacture and operation of this metering device had to be extremely accurate. To look at the picture more factually, imagine that 1 quart of oil were to be applied gradually and accurately over a span of some 4 million revolutions of the engine. This challenge was met by Yamaha and solved with Autolube.

Autolube was the first mass-produced automatic lubricating device to be used on two-cycle motorcycle engines. Developed by the Yamaha Technical Research Institute, it meters the oil with respect to throttle opening as well as engine revolutions and reliably delivers this oil by means of a precision pump.

As a result, the Yamaha two-cycle engines do not have to maintain a single gasoline/oil ratio that most other two-cycle engines must use.

Since the Yamaha Autolube functions according to throttle opening and engine revolutions, it delivers the proper amount of oil to the engine at all times. In addition to these advantages over the conventional oiling system, the distribution of new, fresh oil can readily be recognized as superior to the re-circulating lubrication (used oil) system of four-cycle engines.

OPERATIONAL ADVANTAGES OF YAMAHA AUTOLUBE

1. Excellent lubrication

   In comparison to pre-mixed two-cycle engine lubrication, the Autolube system delivers larger particles of unmixed oil directly to the areas in need of lubrication, thus resulting in less friction.

1. Excellent lubrication (continued)

In comparison to the re-circulated oiling systems of the four-cycle engines, the "never reused oil" type oil system of Autolube means less acids, less varnishes, less contamination of the vital engine parts, and no messy oil changes.

The conventional pre-mix lubrication system has to consider how well the oil will stay mixed with the gas to maintain a proper mixture going to the engine. However, any type oil designed for 2-stroke motorcycles can be used with the Autolube system as the oil is injected right into the engine, eliminating the need of an oil that is compatible with gas.

2. Oil economy

Autolube oil consumption is approximately 1/3 that of the conventional pre-mixing system.

3. Less carbon accumulation

The spark plug, cylinder head, cylinder, piston, piston ring, exhaust pipe, and muffler are coated with less carbon than the conventional system, extending the time between maintenance periods.

4. Less exhaust smoke

Less oil available for combustion means a much cleaner exhaust.

5. Improved engine performance

Combustion efficiency and engine performance have been increased in all phases of operation.

6. Simplified fuel supply

It is not necessary to do any mixing. Straight gasoline goes in the fuel tank; oil goes in the oil tank.

7. Ease of operation

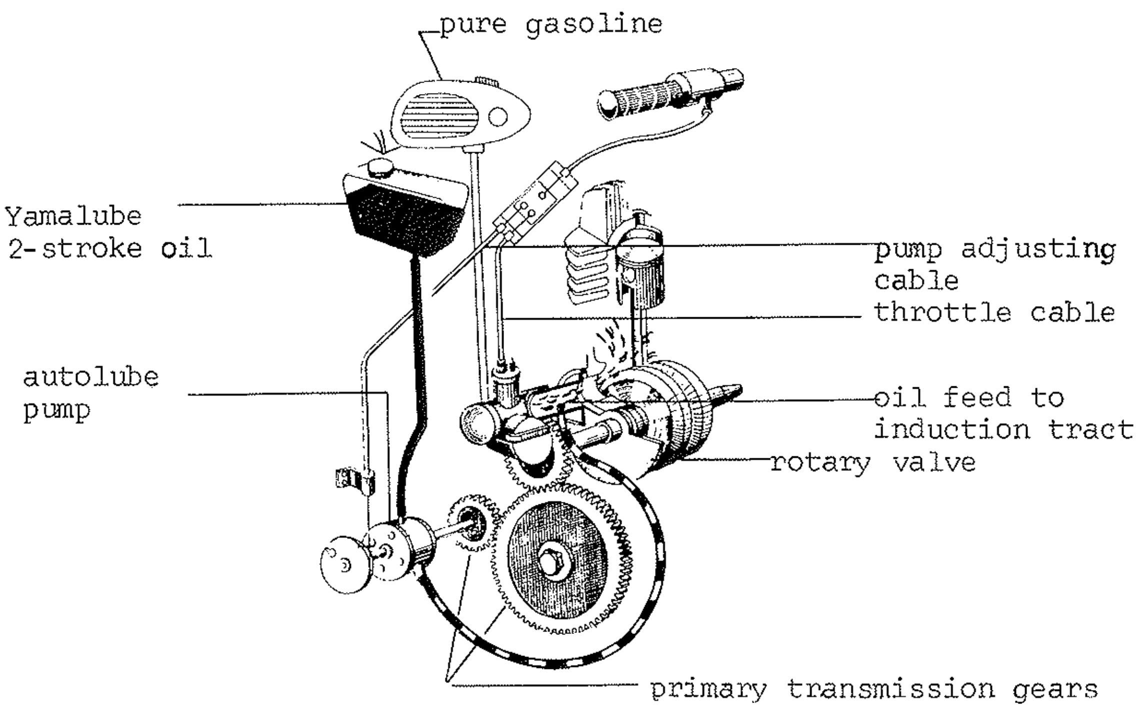
The rider has no problems concerning a correct ratio of gasoline/oil. The pump is pre-set to distribute the proper quantity of oil needed to maintain a correct gas/oil mixture.

MECHANICAL ADVANTAGES OF YAMAHA AUTOLUBE

The oil pump used for the Yamaha Autolube is a gear-driven plunger pump coupled to a rotating distributor. The amount of oil delivered is adjustable. Air, if trapped while pumping, can be completely removed very easily by using an air bleed screw located in the pump body.

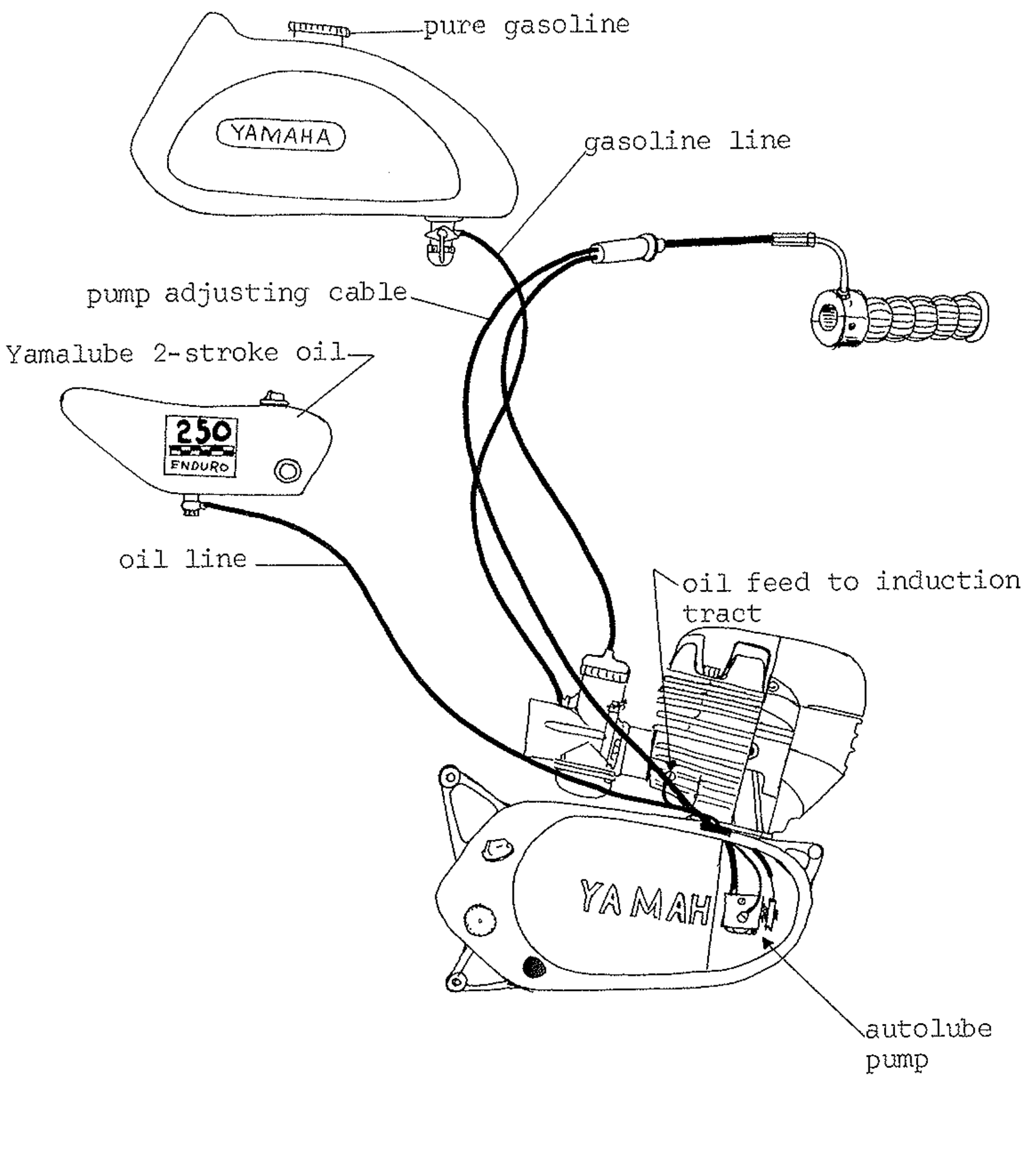
COMPLETE AUTOLUBE SET-UP

(Simplified Single Cylinder, Rotary Valve - Illus. 1)

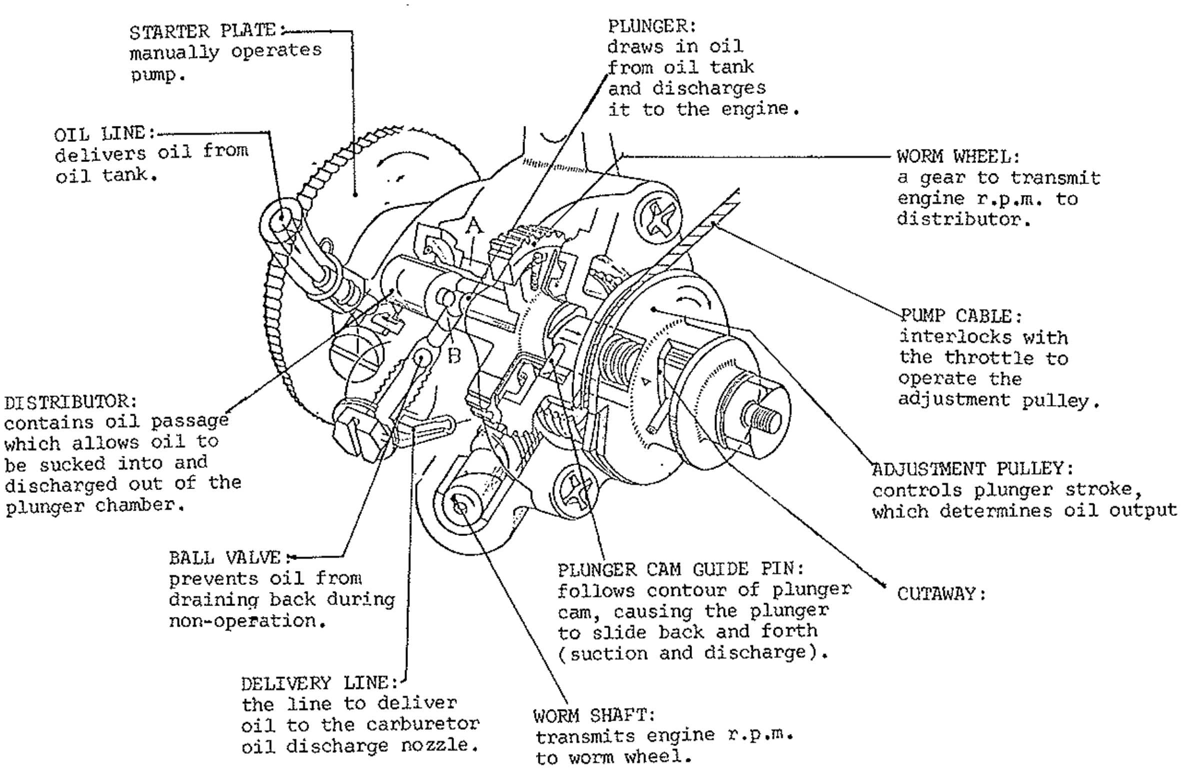


COMPLETE AUTOLUBE SET-UP (continued)

(Simplified Single Cylinder, Piston Port Design - Illus. 2)



PUMP MECHANISM. GENERAL MECHANICAL FEATURES



MAIN PARTS AND THEIR FUNCTION

1. Oil passage

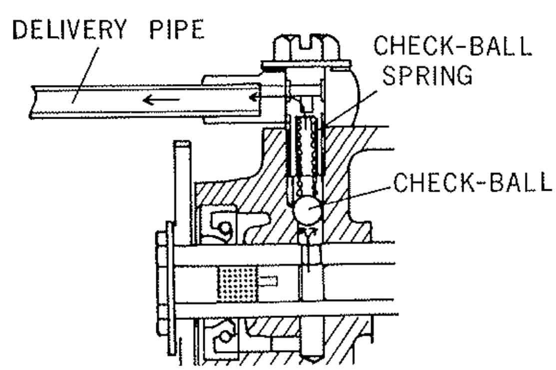
The oil line carries oil from the oil tank into the oil chamber of the pump case and, by action of the plunger, is then drawn into the oil chamber of the distributor through the suction hole in the pump case.

Oil coming out of the outlet hole under pressure pushes up past the check-ball and spring to enter the delivery line which carries it to the nozzle in the rotary valve cover or in the intake port flange. It is then delivered to the vital parts in need of lubrication.

2. Check-ball and check-ball spring

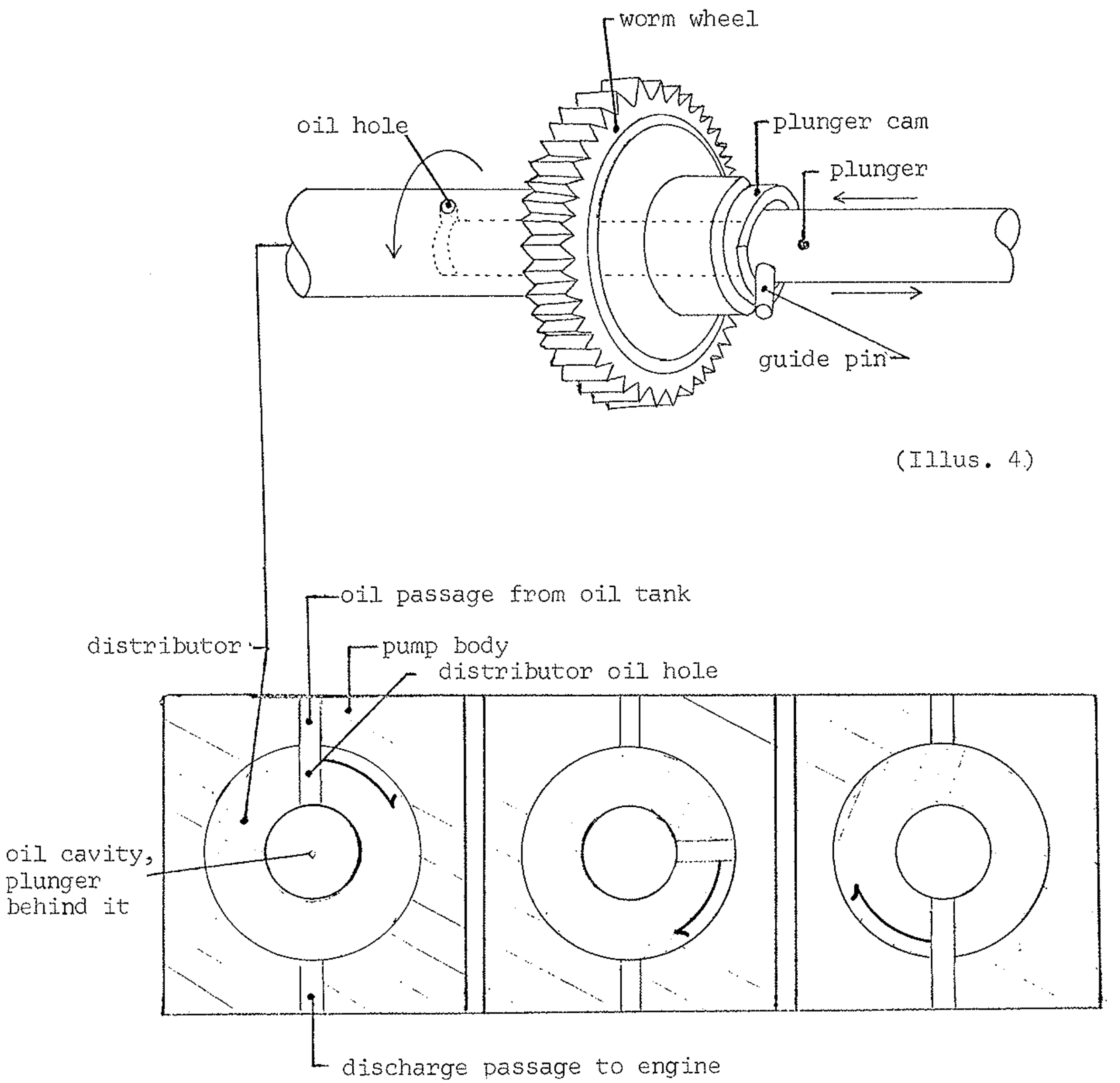
The check-ball and check-ball spring work as a check valve to prevent the oil from seeping back out of the oil line when the engine is not operating. (See Illus. 3)

(Illus. 3)



3. Distributor and plunger

A worm wheel that is attached to the distributor receives rotating motion from the engine. This causes the distributor itself to rotate inside the pump body. On the opposite side of the worm wheel from the starter plate, and attached to the distributor, is the plunger cam. It rotates against the guide pin of the plunger. This guide pin is held against the cam by a spring. As the distributor rotates, the pin follows the high and low contours of the cam. This causes the plunger to move back and forth, sucking and pumping oil as the oil passages line up.



(Illus. 4)

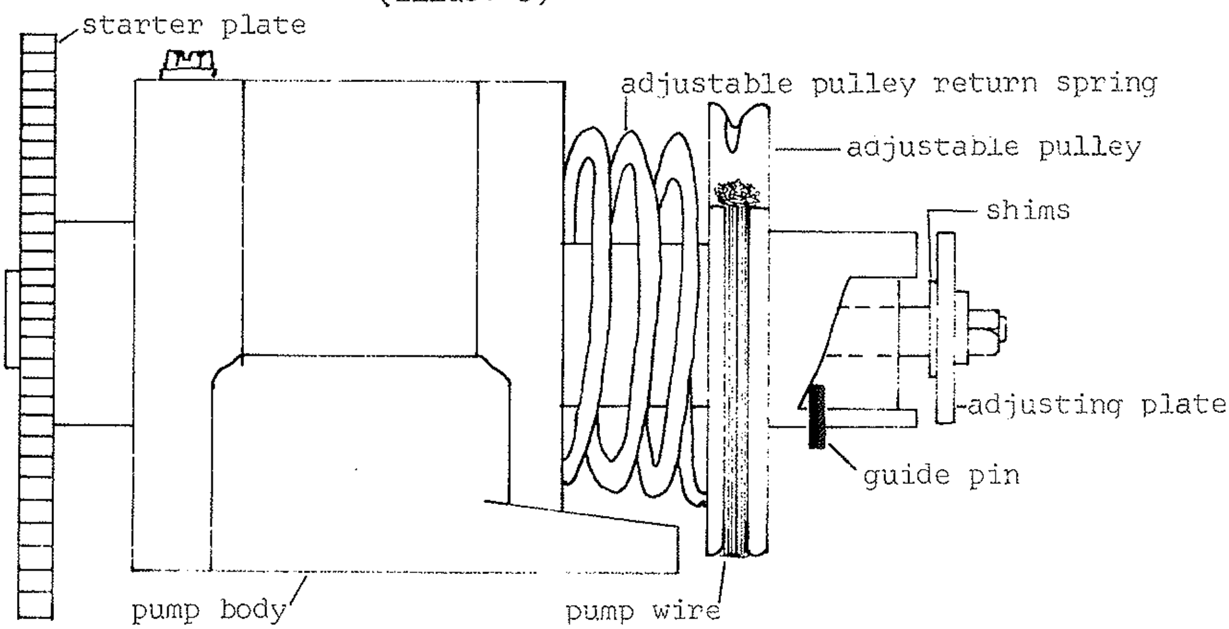
4. <u>Relationship between plunger stroke and throttle opening</u>

The amount of oil delivered to the engine depends on two factors. First is the engine revolutions. As engine RPM rises, the pump action increases also, naturally pumping more oil. An engine turning 10,000 RPM is going to pump more oil than an engine turning 2,000 RPM. The second factor is the length of the plunger stroke. Strictly as an example, consider that a plunger draws back a total of one (1) inch, leaving an equal space to be filled by oil being sucked in. Now if the plunger is drawn back a total of three (3) inches, the volume of oil that can be sucked into the vacated space will be three times as much as the plunger being drawn back only an inch. Total travel of the Autolube plunger can be changed to increase or decrease the amount of oil pumped to the engine.

Total travel of the plunger can be observed by rotating the starter plate one full revolution, and at the same time be watching the adjusting plate. Since the adjusting plate is attached to the end of the plunger, the adjusting plate will show the in and out travel of the plunger.

Plunger travel can be increased by the adjustable pulley. A cable, running from the throttle, is wrapped around the pulley. The adjustable pulley acts as a stop for the adjusting plate-plunger assembly. The adjustable pulley is continually being forced outward by a return spring, but is kept from slipping off the pump body by the guide pin. Now as the pump wire is pulled by the throttle, the pulley rotates. As the illustration below shows, the pulley is forced against the guide pin. Since the pin is stationary, the adjustable pulley is forced back toward the pump body. The gap between the adjusting plate and the pulley is now greater, allowing the plunger to travel forward a greater distance before hitting the pulley, which acts as the stop.

(Illus. 5)



4. <u>Relationship between plunger stroke and throttle opening</u> (continued)

The more the throttle is opened, as in high speed travel, the farther back the pulley is forced. Plunger stroke increases, pumping more oil.

5. <u>Bleeder bolt and starter plate</u>

The bleeder bolt is used when bleeding air out of the pump. Removing the bolt allows oil and air to flow from the oil chamber. The starter plate is used to manually rotate the pump when desired. The pump and its lines may easily be primed by rotating the starter plate.

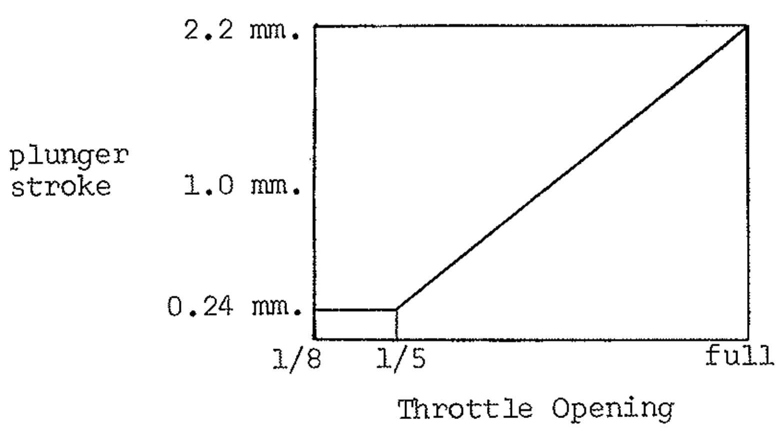
AUTOLUBE PERFORMANCE

1. Oil control

If the plunger stroke were non-adjustable, the amount of oil delivered would be in proportion to engine revolutions only. Under those conditions, it would not be possible for the oil supply to adequately meet the needs of varying riding conditions. If the delivery of oil were to be fixed on the basis of high speed operation, delivery would be excessive at low speed. On the other hand, if it were to be fixed on the basis of low speed operation, this would lead to oil starvation at top speed. In order to prevent these troubles, the Autolube was designed to vary the amount of oil delivered per stroke by controlling the length of the plunger stroke. As the throttle is opened, the plunger stroke becomes longer.

2. Relationship of plunger stroke and throttle opening

Graphic comparisons are as follows:

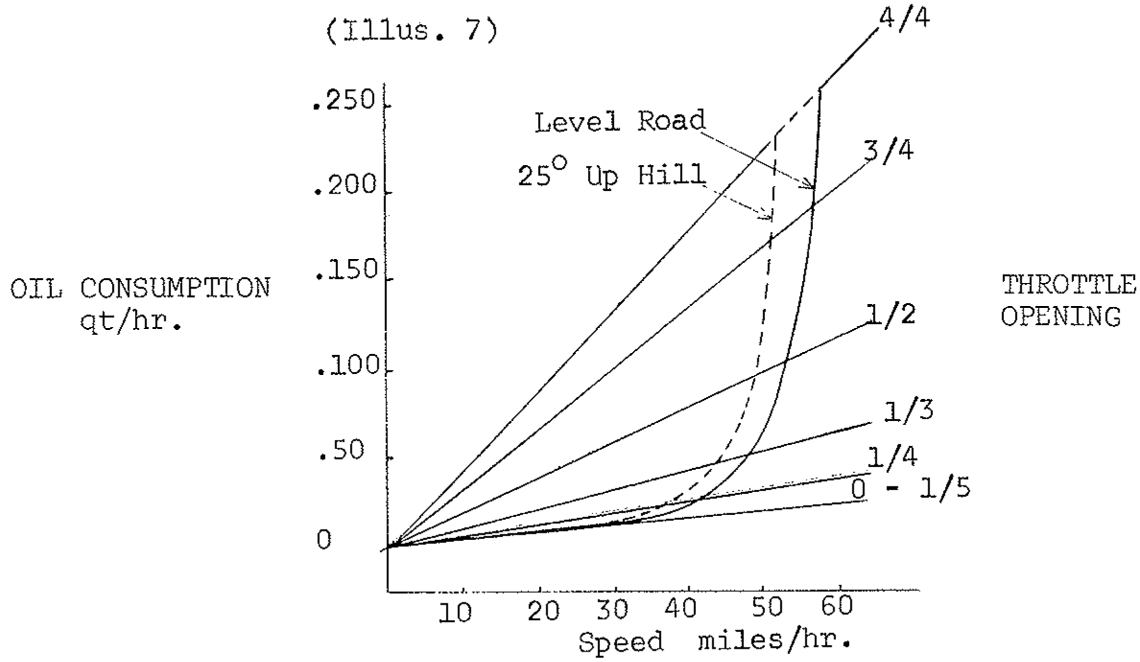


(Illus. 6)

3. Oil Consumption

As shown in the figures below, speed alone is not the sole determining factor of oil needs. Even while running at the same speed, the oil requirement for climbing a hill is much more than for driving on a paved, level road because of the greater throttle opening. For example: Under level operating conditions, the engine uses 1/4 oz/hr at 25 MPH. When the throttle is opened to 1/3 for acceleration, oil consumption immediately reaches about 7/8 oz/hr before speed increases take place. Since engine revolution increases with sustained acceleration, further oil consumption changes follow.

(Illus. 7)



4. Gasoline-to-oil ratios:

The gasoline-to-oil ratios, for driving on a paved level road in 4th gear, varies as follows:

THROTTLE SETTING	20 MPH	40 MPH	60 MPH	TOP SPEED
1/4	100:1	70:1	60:1	
1/3	90:1	65:1	50:1	
1/2	60:1	50:1	30:1	
full throttle	30:1	25:1	19:1	18:1

(Illus. 8)

4. <u>Gasoline-to-oil ratios</u> (continued)

The gas-oil ratio is about 18:1 when the motorcycle is in high gear and travelling over 65 MPH. This ratio combats overheating and seizure problems. At less than 1/5 throttle opening, the pump is at minimum feed (approximately 120:1), allowing adequate lubrication even when the throttle is shut off after the engine reaches high RPM. This means that there is no oil starvation even if the engine is used as a brake for a long period of time - a revolutionary difference from conventional pre-mix oiling systems.

Compare the amount of oil-to-gas actually needed throughout the entire throttle opening range to the standard 20:1 oil/gas ratio of conventional pre-mix setups. Notice that pre-mixes run much heavier than necessary at idle, and yet provides barely sufficient lubrication at high speeds.

By controlling oil-to-gas ratios, oil usage and engine operation are improved.

PUMP SETTING

It is necessary to first adjust the carburetor and cables before making pump adjustments because the pump cable itself is directly connected to the throttle cable. As the carburetor is opened, the pump cable begins to change the pump output. If a throttle adjustment is made later, it is possible that the pump setting could change too.

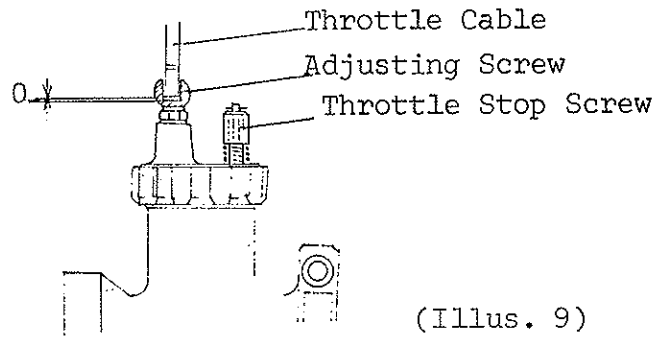
I. Preliminary carburetor adjustments.

Note: For the purpose of illustration, the adjustments will pertain to twin cylinder engines. The same steps will be followed for single cylinder models, but disregard the section about synchronizing the carburetors.

A. Synchronize the throttles as follows:

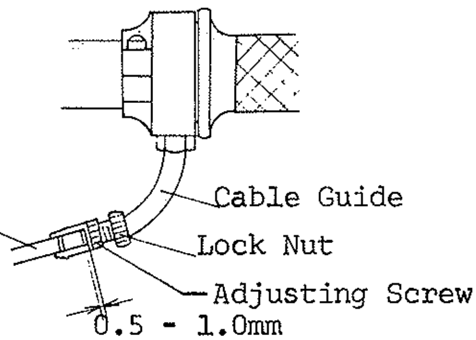
1. Disconnect the rubber intake elbows. Adjust the throttle stop screw so the slides are completely down. Put a finger in each carburetor and open the throttle slowly, several times. If the slides do not start up simultaneously, adjust the throttle cables until they do. Make sure that the slides are starting up from idle position each time.

2. (Another simple method). Lightly lift the throttle cable housings at the top of each carburetor. Adjust each cable housing to have exactly the same amount of free-play at point "A". By setting them in this manner, the two slides will have to lift simultaneously. (See illustration #9).



(Illus. 9)

3. Make the play of the throttle cable 0.5 to 1.0mm (See Illus. 10) by pulling the outer cable and turning the adjust screw. This play is necessary to allow the cables to flex when the handlebars are turned, without affecting the throttle opening.



(Illus. 10)

4. Start the engine. Set the idle at 1,000 - 1,200 RPM by adjusting the throttle stop screw.

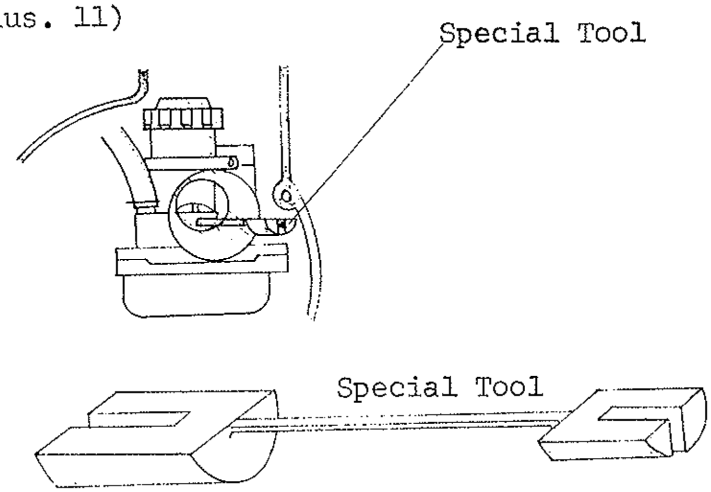
II. Pump Cable Adjustment

A. Single cylinder models (except DT-1).

1. After mounting the pump on the engine, connect the pump cable.

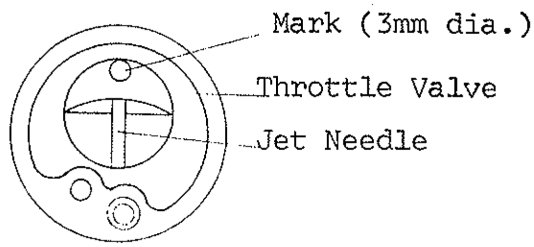
2. Turn the throttle 1/2 open and keep it there by the use of the special tool shown below.

(Illus. 11)



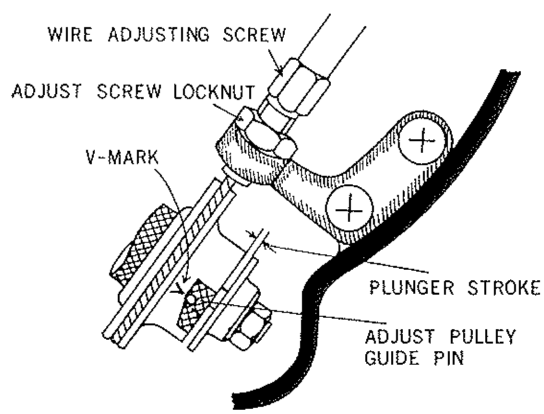
II. Pump Cable Adjustment (continued)

3. Later single cylinder models have a small circle marked on the throttle slide. (See Illus. 12) Twist the throttle until the top of the small circle just touches the top of the carburetor bore. The slide is now at 1/2 opening.



(Illus. 12)

4. Match the V-mark that's stamped on the pulley to the pulley guide pin. This can be done by turning the adjusting screw at the end of the pump cable housing. (See Illus. 13).



(Illus. 13)

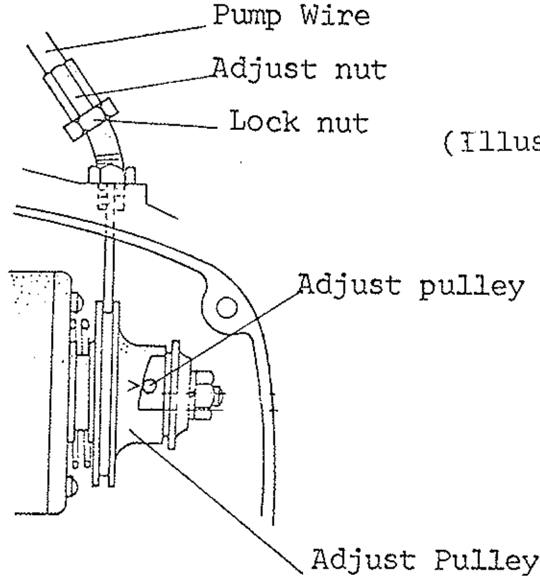
II. Pump Cable Adjustment (continued)

B. Twin cylinder models (See Illus. 14).

1. Mount the pump and hook up the pump cable.

2. Close the throttle completely.

3. Match the V-mark to the pulley guide pin by turning the adjusting screw at the end of the pump cable housing.



(Illus. 14)

III. Pulley Gap (plunger travel)

The gap between the pulley and the adjusting plate is equal to the total plunger travel. It is necessary to make this gap a minimum of .009" - .012". This can be done by doing the following:

1. Shut the throttle completely off, if it has not already been done.

2. Rotate the plastic starter wheel until the pulley gap is at its widest opening.

3. Measure the gap with a feeler gauge. Always measure the gap at its narrowest spot. That is where the small "bump" is located on the adjustable pulley.

4. The gap can now be adjusted wider or narrower by inserting or removing the thin shims located under the adjusting plate.

5. Always recheck the gap to be sure a correct adjustment has been made.

6. It should be noted that all models have the same minimum gap. However, individual service manuals will show a different maximum gap. The maximum gap can be found by cranking the throttle completely open, and measuring the same gap described in #3. Pumps that are received from the factory are already adjusted, and it is rare that after setting the minimum gap, the maximum is not also correct.

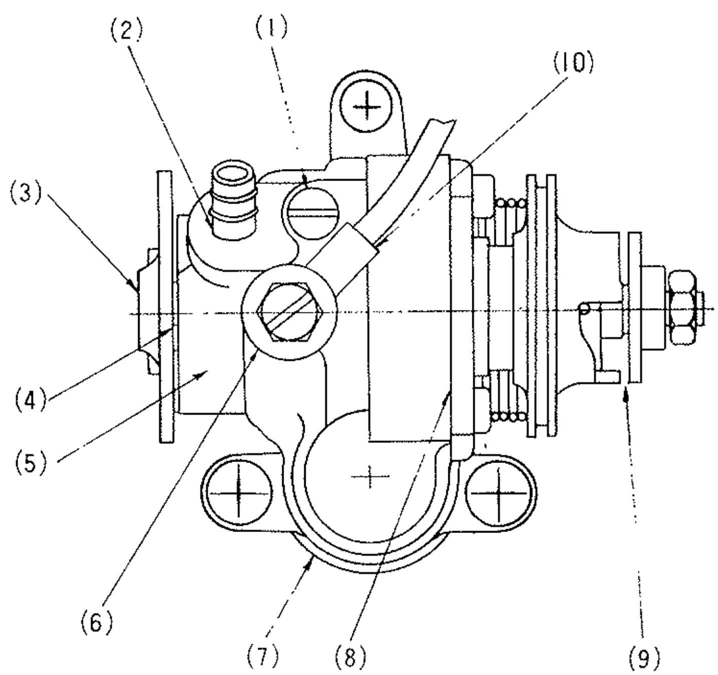
REMOVING AIR FROM THE PUMP (BLEEDING)

Remove the bleeder bolt to bleed the pump. Next, twist the throttle fully open to increase pump stroke to its maximum. Now turn the starter plate in a clockwise direction until oil continuously runs out through the breather bolt hole. It will take several full rotations of the starter plate to remove the air.

Another simple and safe way to speed up the bleeding process is to start the engine and let it idle. Remove the bleeder screw. Observe the oil being pumped out of the hole and insert the bleeder screw as soon as there are no more air bubbles. It should be stressed that this procedure should only be done with the engine at idle speed. It will not take very long.

TROUBLE SHOOTING

TROUBLE	PROBABLY BECAUSE	REMEDY
1. Poor oil delivery	a. Bubbles in oil in the pump case.	a. Bleed the pump in the way mentioned before.
		b. Check the following points for oil leaking; replace the pump if necessary:
2. Pump constantly on minimum stroke.	a. Pulley guide pin has fallen out.	a. Replace pump.
	b. Pump cable unhooked or broken.	b. Reconnect or replace cable.
3. No plunger action.	a. Plunger guide pin missing.	a. Replace pump.



(1) Breather gasket.

(2) Suction pipe connector and pump case.

(3) Distributor oil seal.

(4) Distributor plug.

(5) Pump case.

(6) Banjo and pump case.

(7) Pump and crankcase cover.

(8) Pump case cover & pump case.

(9) Terminal of plunger; plunger cover, plunger cam oil seal and plunger oil seal.

YAMAHA

CARBURETION

CARBURETION

CARBURETION

PRINCIPLES AFFECTING CARBURETOR OPERATION

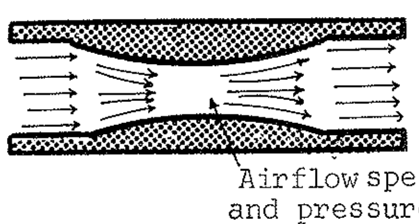
The carburetor is a mechanical device designed to meter, mix and deliver air and fuel to the engine.

Air and fuel must be combined in the proper ratio to insure good combustion. The various jets and air passages act as metering devices to get the correct fuel-air ratio. Theoretically, the correct fuel-air mixture is 15:1, by weight. That is, fifteen (15) pounds of air to one (1) pound of fuel. Be sure to understand the ratio to be a weight ratio, not a volume ratio. This ratio allows sufficient fuel to be supplied to combine with all the oxygen. An economical mixture would be approximately 16-20:1 and a rich mixture would be 10-14:1. It is advisable to run a slightly rich mixture in Yamahas as the extra fuel helps to cool the engine by drawing off some cylinder heat through fuel mixture evaporation.

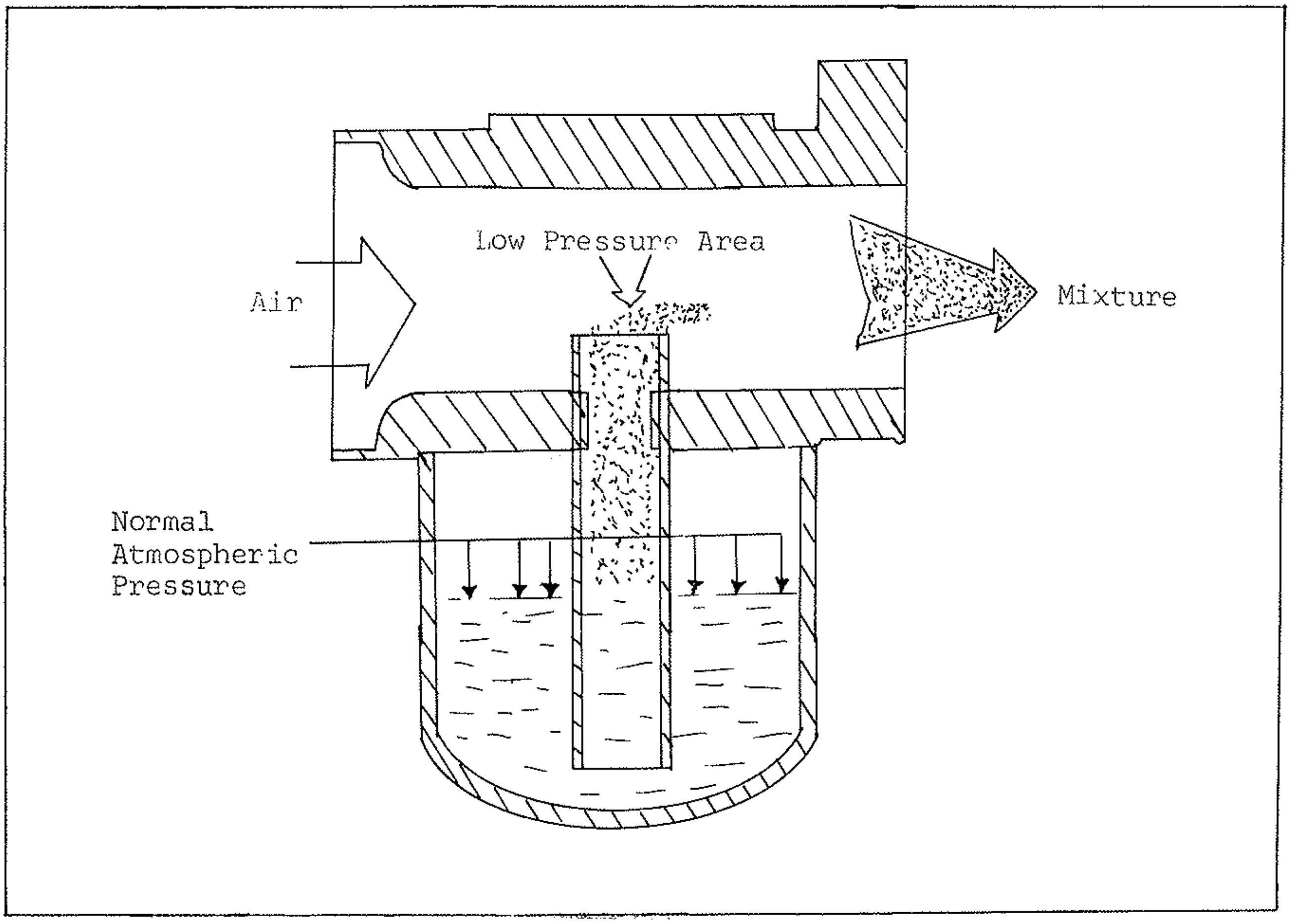
Another principle to aid in combustion is atomization. Atomization is the process of breaking up gasoline droplets into very fine particles. Atomization benefits combustion in two ways. First, since the fuel is reduced to many fine particles, greater surface area of the gasoline is exposed and more oxygen can combine with the gasoline. This provides more complete burning of the fuel, therefore more power. Secondly, gasoline that has been reduced to a fine mist will much more easily follow the contours of the carburetor intake, crankcase, and transfer ports to the combustion chamber because it is light. The principle of atomization therefore greatly effects correct fuel and air delivery.

Air that passes through an enclosed tube at a high velocity creates a low pressure area against the walls of the tube. This is caused by air molecules "stretching out" at high speeds, thinning the density of the air and effectively lowering the air pressure below the standard atmospheric pressure. The higher the air speed, the greater the pressure drop. The tube is always known as the "venturi", and the combination of the venturi and air-flow to lower the air pressure is called "venturi action". The carburetor obtains its fuel supply needed by the engine because of this venturi action. A fuel delivery tube is located in the venturi and extends down into a reservoir of gasoline. The gas is forced up to the venturi by unequal pressures. Air drawn through the venturi creates the lower pressure at the venturi end of the gas delivery tube while normal atmospheric pressure is pushing down on the gas in the float bowl. Air pressure in the float bowl is higher than the venturi air pressure, so gas is forced up the tube into the venturi in an attempt to equalize

CROSS SECTION OF VENTURI IN OPERATION



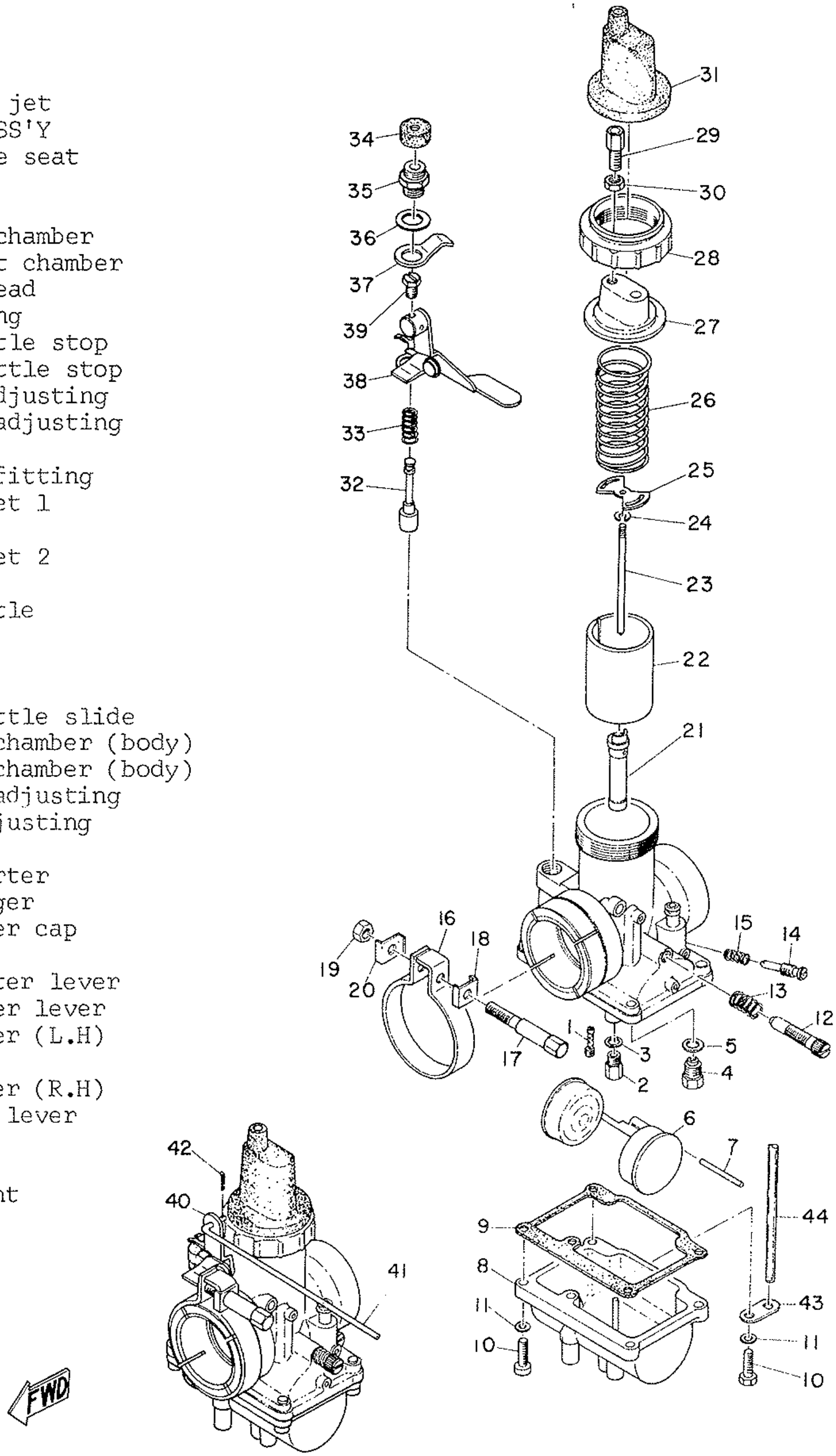
the low pressure area. The amount of gasoline allowed to pass up to the venturi is controlled by jets placed in the delivery tube. As air rushes through the venturi, it picks up the gas coming out of the delivery tube. The gas and air mix and both are drawn into the cylinder.



Air speed through the venturi to a great extent relies on the action of the upward travel of the piston. The air speed is partially affected by the amount of throttle opening and the size of the venturi, but piston travel is the basic mover of the air. Notice that there really isn't much air flowing through the venturi when the motorcycle isn't running, no matter what the size of the venturi, nor how far the throttle is open. As the piston travels upward opening the intake port (do not forget that we are talking about 2-strokes), it creates a low pressure area (partial vacuum) in the crankcase. Air will rush through the venturi in an attempt to equalize the low pressure area. Page one explains how this action picks up the gas and carries it into the engine.

CARBURETOR BREAKDOWN - ILLUSTRATION

1. JET, pilot
2. JET, main
3. WASHER, main jet
4. VALVE SEAT ASS'Y
5. WASHER, valve seat
6. FLOAT
7. PIN, float
8. BODY, float chamber
9. GASKET, float chamber
10. SCREW, pan head
11. WASHER, spring
12. SCREW, throttle stop
13. SPRING, throttle stop
14. SCREW, air adjusting
15. SPRING, air adjusting
16. CLIP, outlet
17. SCREW, body fitting
18. WASHER, outlet 1
19. NUT, holding
20. WASHER, outlet 2
21. NOZZLE, main
22. SLIDE, throttle
23. NEEDLE
24. CLIP
25. SEAT, spring
26. SPRING, throttle slide
27. TOP, mixing chamber (body)
28. CAP, mixing chamber (body)
29. SCREW, wire adjusting
30. NUT, wire adjusting
31. CAP
32. PLUNGER, starter
33. SPRING, plunger
34. COVER, plunger cap
35. CAP, plunger
36. WASHER, starter lever
37. PLATE, starter lever
38. LEVER, starter (L.H)
39. SCREW, rod
40. LEVER, starter (R.H)
41. ROD, starter lever
42. PIN, cotter
43. PLATE
44. PIPE, air vent

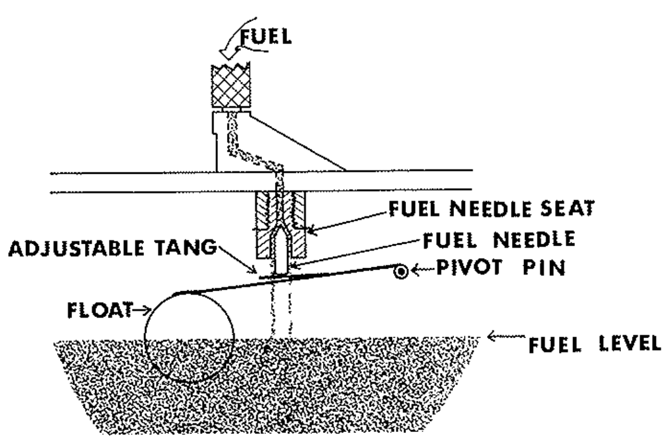


CARBURETOR OPERATION
(according to throttle opening)

This section discusses when and how the components function as the throttle is progressively opened until 'full throttle' is attained. Definite fuel, air and combined fuel/air 'circuits' exist in the carburetor. As the throttle slide is lifted to increase engine power, different circuits come into action to supply the added quantity of fuel and air necessary. This section is divided and explained according to the progressive actuation of these circuits. Understanding the definite division between these circuits, and when and how they function, will be an invaluable aid in the future when you are called upon to repair a Yamaha that is suffering from a carburetor malfunction. You will be able to pinpoint the particular circuit that is faulty by determining at what throttle opening the malfunction occurs.

Venturi: The venturi, many times called the main bore, is the large air passage that extends through the entire length of the carburetor body and directly lines up with the induction tract leading to the crankcase. It serves two purposes. It supplies the passage for air to flow into the engine crankcase, and also to create the low pressure area over the fuel nozzle. The fuel nozzle is the upper tip of the fuel delivery tube and it extends slightly into the venturi. It is located in the center of the venturi and provides a discharge spout for fuel that is drawn up from the float bowl.

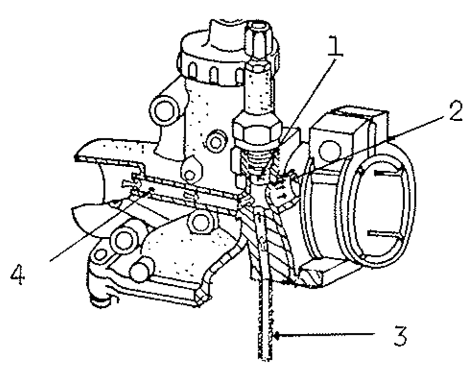
Float: The float bowl contains a ready supply of gasoline for the engine's use. It is necessary that a precise level of fuel be constantly maintained in the float bowl. The fuel level is controlled by the float, float needle and float needle seat. If you take a close look at the float assembly, you can see that the float pivots up and down on the rod. The adjustable tang of the float arms touches the bottom of the fuel needle (also called the 'float valve'). Gasoline will flow from the gas tank, past the fuel needle, and into the float bowl. The float itself will ride on top of the fuel level. When the float is lifted to a pre-determined height by the gasoline, the float tang will push the needle firmly against its seat, stopping the flow of fuel. Naturally the engine will continually draw gasoline out of the float bowl and almost immediately the fuel level will drop. This will again start the chain of events as the float will drop with the fuel, the needle will fall away from its seat, fuel will again flow from the gas tank, past the needle and into the float bowl.



Starter Circuit: It is a fact that a rich air/fuel mixture is sometimes needed to start an engine, especially a cold one. Air speed through the venturi is slow, so there is very little pressure drop. The gasoline is not readily and evenly picked up by the air and carried to the crankcase for use by the engine. Also, fuel that is picked up is not very efficiently atomized, as it takes, among other things, a fast air flow to break up the fuel particles. It has already been explained why atomization is important (PRINCIPLES AFFECTING CARBURETOR OPERATION). In order to allow for poor atomization, the fuel mixture must be richened to provide sufficient gasoline to combine with the available air.

One method employed on motorcycles to richen the mixture for starting purposes is to use a choke that restricts the amount of air flowing through the venturi. This effectively richens the mixture, but it also limits the entire quantity of fuel and air available to the engine. Also, the fuel/air mixture of a motorcycle using a conventional choke type system gets increasingly richer as rpm's increase. This occurs because a greater amount of fuel is sucked into the engine as the throttle is opened further, while the choke blocks any possibility of more air being drawn into the engine. To get an idea of how this occurs, use your hand to partially block off the carburetor air intake. Start to rev up the engine. If the throttle is opened far enough, the mixture eventually might become rich enough to 'kill' the engine.

The Mikuni carburetor uses a much more efficient method to start the motorcycle. A completely separate 'starter system' is built into the carburetor. The starter system has its own air and fuel passages (with non-replaceable jets) as shown in the illustration below. The air and fuel passages are drilled straight to the starter mixing chamber. The fuel and air are mixed together and drawn out to the venturi through the passage that has been drilled from the starter mixing chamber to the venturi. This passage is located high in the mixing chamber. The separate air passage enters the mixing chamber in the middle and the fuel passage is drilled into the bottom of the chamber. The starter system is activated by pushing the starter lever down. This lifts the starter plunger up, effectively allowing air and fuel to enter the mixing chamber, mix together, and then exit out the passage into the venturi. As the plunger is pushed back down, after the engine starts, all the passages are blocked off. Because the 'starter jet system' does not block the carburetor air supply, the final fuel-air mixture does not become increasingly richer as the throttle is gradually opened.



1. Plunger
2. Mixture Passage (to venturi)
3. Fuel Passage
4. Air Passage

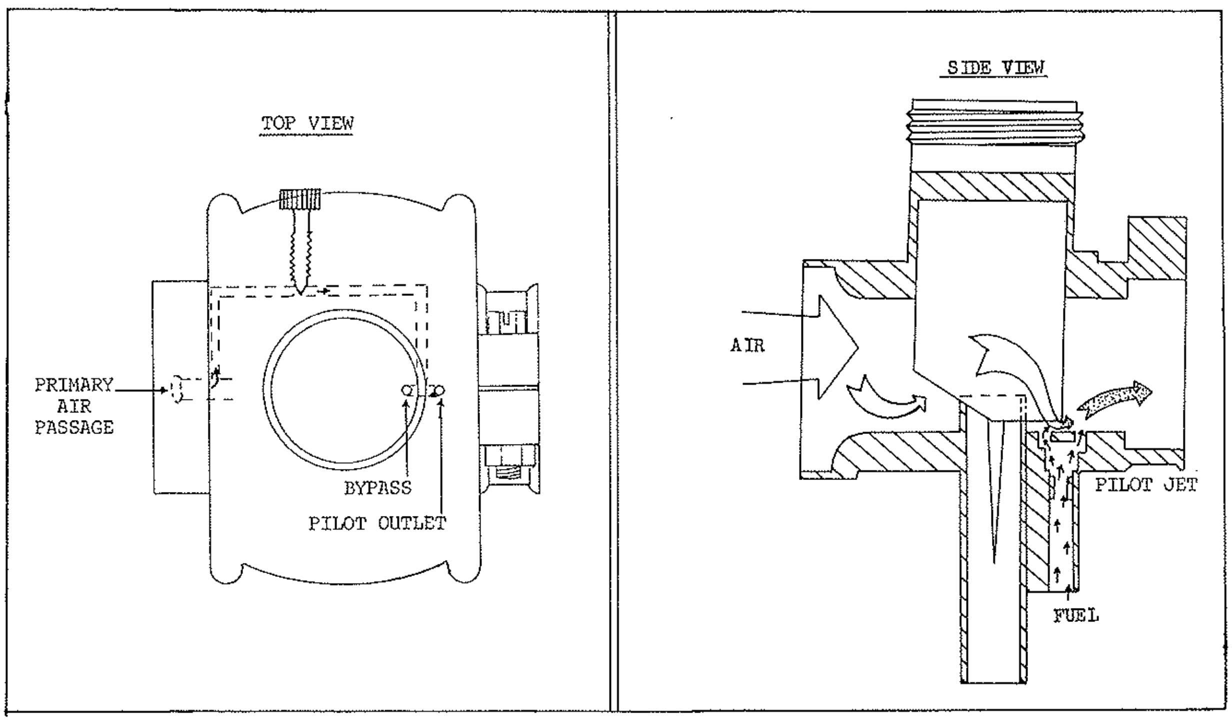
Idle Circuit--0-1/8 Throttle Opening: An idling engine does not require much fuel and air from the carburetor. For this reason, the fuel and air passages that make up the 'idle circuit' are quite small. This circuit consists of the pilot air passage, the throttle slide-venturi combination, and the pilot jet passage that leads up from the float bowl to the venturi.

Fuel for the idle circuit is forced up through the screw-in type pilot jet. The jet has a very small, precision drilled hole to meter the correct amount of fuel. The difference in pressure between the float bowl (normal atmospheric pressure) and the venturi (piston suction creating a less-than-atmospheric pressure) causes fuel to be drawn up the pilot jet passage toward the venturi. The illustration below shows that the pilot jet passage meets the pilot air passage at a spot just below the venturi openings, forming, and performing as, a miniature mixing chamber.

The idle circuit has two air supply sources. The first, the venturi-throttle slide combination, supplies a large and constant quantity of air. This air combines with the fuel to obtain an approximately correct fuel-air ratio. The second source, the pilot air passage, supplies a lesser but very important quantity of air. It's important because this air passage, controlled by the pilot air screw, provides an adjustable quantity of air needed to obtain the correct fuel-air ratio.

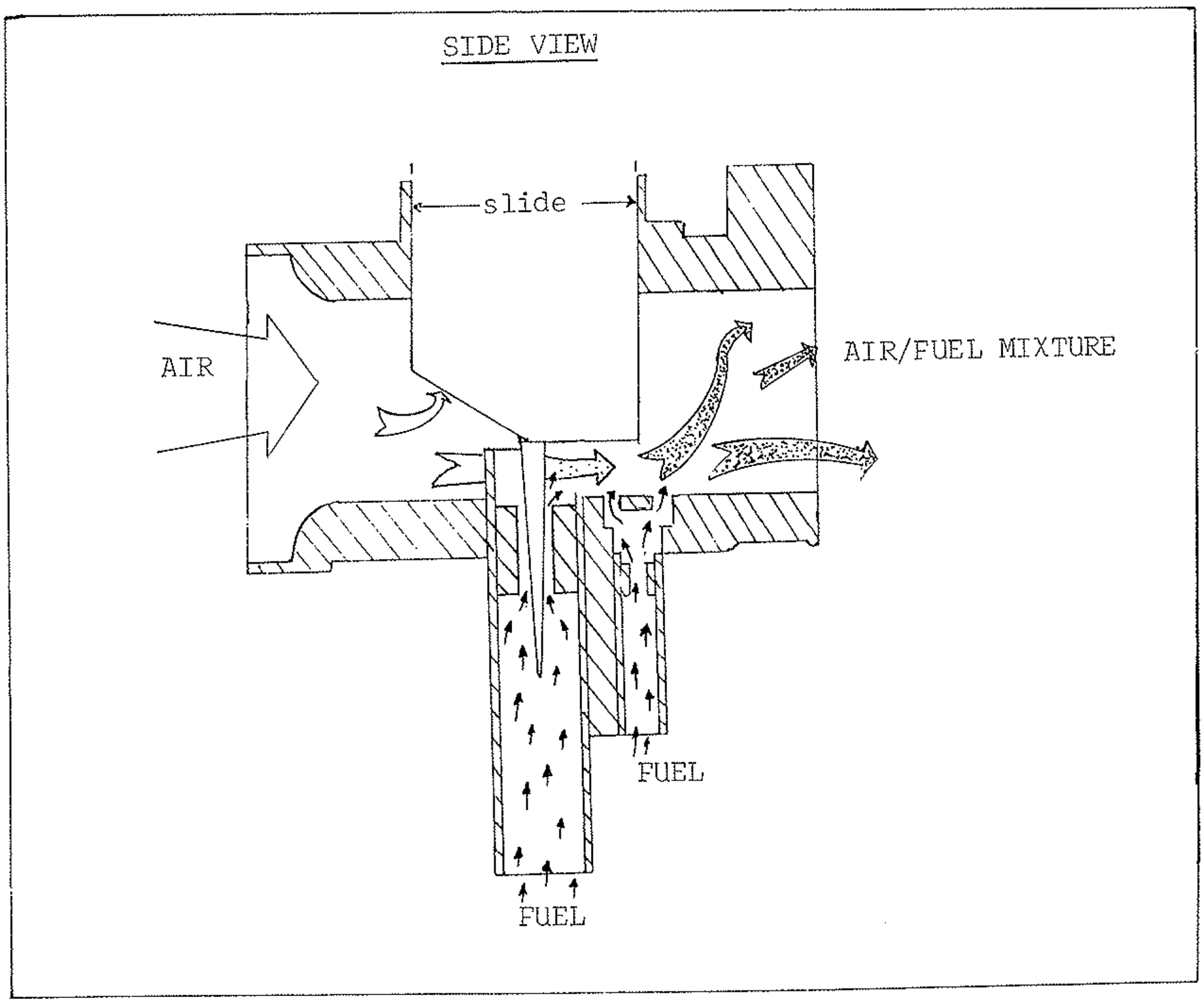
During operation, the fuel-air mixture enters the venturi through two outlets; the 'pilot outlet', located in back of the slide, and the 'bypass', which is located within the circumference of the slide. Now that the passages have been identified, the action of these passages during operation needs explanation.

The rising engine piston creates a suction in the induction area behind the throttle slide. Outside air pushes through the pilot air passage in an attempt to equalize the area with this suction and mixes with the fuel coming up through the pilot jet passage. Air rushing under the slightly lifted slide mixes with the fuel-air mixture, and helps to carry the mixture to the crankcase.



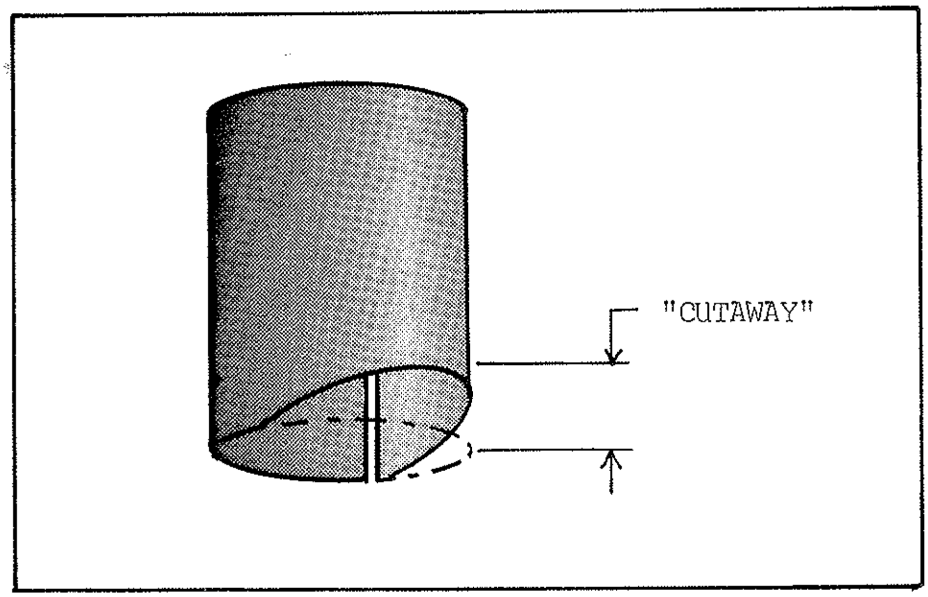
Slow Speed--1/8-1/4 Throttle Opening: As the throttle slide is raised from the idle position more air is allowed to pass through the venturi. The components now controlling mixture include the aforementioned idle circuit and the slide itself.

Fuel flow from the idle circuit increases due to greater air flow over the bypass outlet. This air flow creates a suction which draws additional fuel from the pilot jet. In addition, fuel will now start flowing from the main nozzle due to air flow over it. This air flow over the main nozzle outlet is controlled, at this stage, primarily by the slide cutaway.



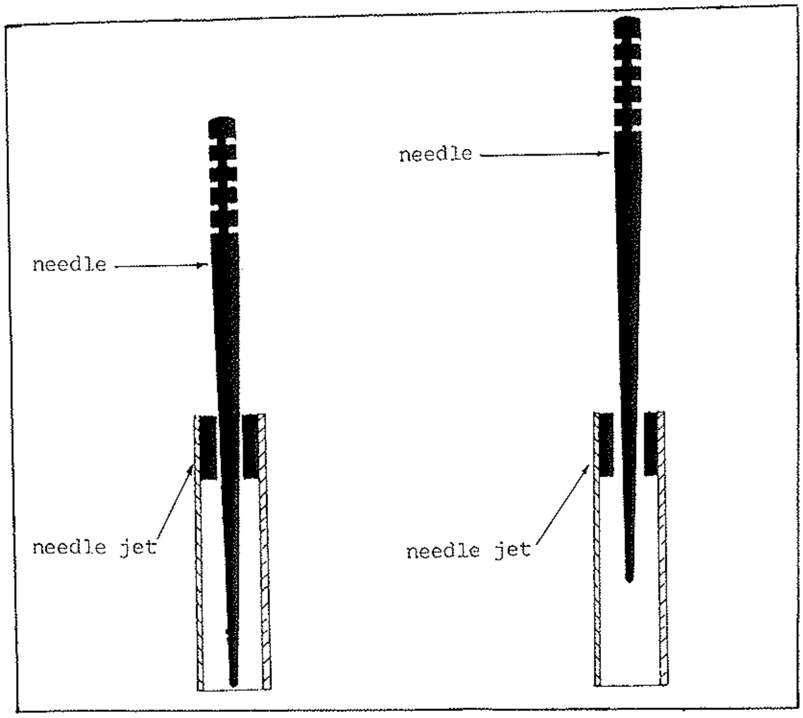
The throttle slide acts as a sliding valve that regulates the flow of air through the venturi. It is located in the middle of the venturi. A cable, attached at one end to the throttle grip, is hooked into the slide and twisting the throttle grip results in the slide moving up, allowing a greater quantity of air to flow to the engine.

The slide has its front section 'cutaway' (The slide section facing the air cleaner). The reason for this is to supply extra air to the carburetor at 1/8-1/4 throttle opening. When the throttle is quickly opened from an idle, a considerable vacuum is created over the fuel nozzle. If there were no cutaway, the vacuum of the engine would draw a great amount of raw gas out of the fuel nozzle and into the engine (quite unburnable). But when there is a cutaway, air from the area outside the engine (at normal air pressure) is allowed to partially fill the area inside the throttle slide and over the fuel nozzle. This extra air helps to reduce the possibility of an excessive vacuum over the fuel nozzle and also is sucked in to mix with the gas, creating a very burnable mixture.

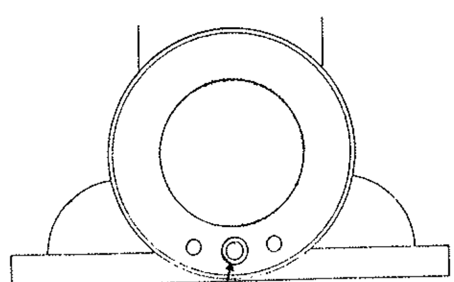


<u>Mid-range Circuit--1/4 - 3/4 Throttle Opening</u>: As the throttle is raised for increased power, additional fuel and air is needed to supplement, and eventually override, the slow speed circuit. The mid-range circuit draws air from two sources; (1) air passing through the venturi, and (2) air drawn in through the primary air passage (drilled from the venturi inlet to the fuel nozzle). Additional fuel is delivered through the jet needle-needle jet combination. They provide an adjustable metering system to control the fuel output.

Half-throttle will be used as an example. At half-throttle, air rushes through the venturi and creates a low pressure area over the fuel nozzle. Gasoline is forced up the needle jet. The jet needle (also called the metering rod), which is attached in the center of the throttle slide, rests in the drilled passage of the needle jet. At half-throttle the needle, because of its taper, allows the correct amount of fuel to get by and mix with the air rushing through the venturi. The taper of the needle is what controls the amount of fuel to flow into the venturi. The higher the throttle slide rises the more fuel will flow past the needle.



Primary air passage; this air passage aids atomization of the fuel that passes through the needle jet and into the venturi--the greater the atomization, the more efficient the engine will be. The air passage has its opening at the very front of the carburetor (it usually shares a common entrance hole with the pilot air passage).

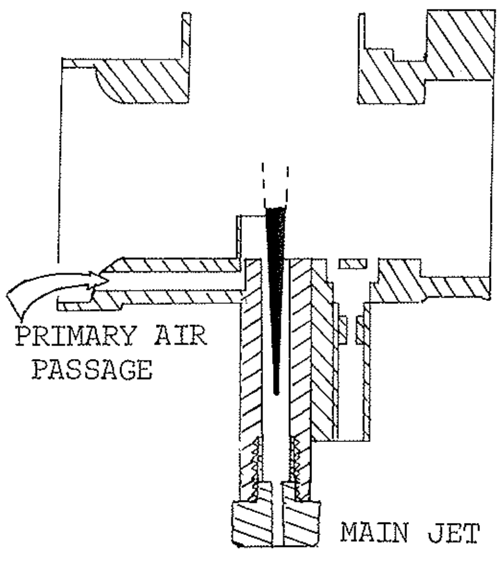


FRONT VIEW--PRIMARY AIR INTAKE.

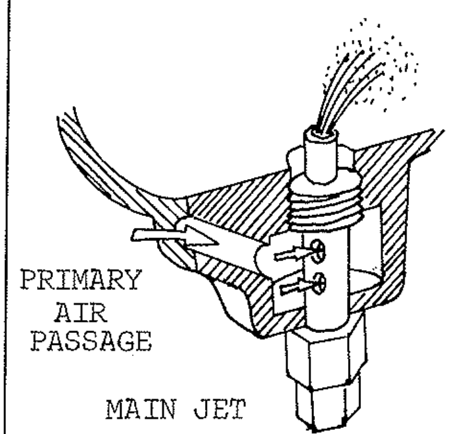
Primary air passage (continued)

Air from the primary air passage is channeled into the needle jet to accomplish this atomization. The Mikuni carburetors are drilled in one of two different ways to direct the primary air to the needle jet. The first type, the 'primary' type, directs the primary air to the needle jet at a point just below the fuel nozzle. The second type, the 'bleeder' type, directs the primary air into the needle jet chamber located near the base of the needle jet. Practical tests have shown that the 'primary' type supplies more power, while the 'bleeder' type is more economical.

NOTE: The primary type carburetor fuel nozzle extends into the venturi air flow about 5/16". Also, the back part of the fuel nozzle is cut away. This is an additional aid to atomization of the fuel coming out. Fast moving air swirls around the projection and this turbulence helps to further break up the gasoline particles.



SIDE VIEW--CUTAWAY SHOWS PRIMARY AIR PASSAGE OF 'PRIMARY' TYPE CARBURETOR.



CUTAWAY VIEW OF 'BLEEDER' TYPE CARBURETOR--AIR PASSAGE LEADING DOWN TO NEEDLE JET CHAMBER.

<u>High Speed Circuit--3/4 Full Throttle:</u> The jet needle and needle jet lose their effectiveness as a fuel metering device after 3/4 throttle. Another method of fuel flow control is needed to properly meter the fuel to the engine. The 'main jet' is the carburetor part designed to meter the gasoline to the venturi and eventually to the engine.

The main jet screws into the bottom of the needle jet. The main jet has a hole drilled through it to allow the proper amount of fuel to pass up to the venturi at full throttle and still maintain the correct fuel/air mixture. Air supply for the high speed circuit still comes through the venturi, and the separate air passage that aids in atomization of the fuel still functions at full throttle.

DISASSEMBLY

Disassembly is a simple procedure, but there are certain mistakes that can occur if the carburetor is not taken apart carefully. This procedure is recommended whenever the carburetor is taken apart for cleaning, jet replacement, float setting or troubleshooting of any sort.

In preparation for carburetor tear-down, it is always a good idea to have a flat clean surface to work on. Lay down a clean cloth so that the parts that are removed can be kept clean and unscratched.

1. Turn the gas switch off and disconnect the fuel line.

2. Disconnect the choke linkage between the carburetors where applicable.

3. Unscrew the top ring and pull out the slide assembly.

4. Loosen the pinch bolts or flange hold down bolts, depending on the model, and remove the carburetor(s) from the motorcycle.

5. Remove the starter jet assembly.

6. Turn the carburetor upside down and remove the four (4) float bowl screws. Remove the float bowl from the carburetor body. (When doing this step, be prepared for gasoline from the float bowl to drain out at inopportune moments).

7. While the carburetor is still upside down, push the float pin out and set the float with the other disassembled parts. Be careful to note which way the float comes out as it could possibly be put in upside-down. This fact would eventually be discovered because the float bowl would not fit back on, but the float could be bent out of adjustment in the process. This would require the float level to be reset - very unnecessary with a little precaution. Also watch that the fuel needle doesn't fall out unnoticed after the float is removed as the float is the only thing holding it in.

8. Remove the fuel needle from the carburetor and unscrew its seat.

9. The main jet and needle jet are removed next. First, unscrew the main jet from the bottom of the needle jet (all Yamaha carburetors, except the DT1 type carburetor, have the main jet screwed into the bottom of the needle jet). Yamaha carburetors are designed with two different methods of retaining needle jet. They are removed in different ways. Some models have a 'screw-in' type of needle jet. Simply unscrew it for removal. Some models utilize a press-fit needle jet. To remove this type (after main jet has been removed), you must first pop out the thin washer that is press-fitted at the bottom of the needle jet. The tip of a thin knife blade can easily be slipped under the washer to lift it out. Next, lightly tap the needle jet up from the float bowl end, and force the jet into the venturi area.

10. The pilot jet (idle) is next removed. A small flathead screwdriver is necessary to reach the pilot jet as it is located deep inside the fuel delivery tube that is right next to the main and needle jets.

The carburetor is an efficient mechanical device because it has very few moving parts. It is difficult for a carburetor to 'wear out'. However, periodic maintenance is necessary in order to keep the carburetor functioning correctly. The problems that occur in the carburetor could stem from varnishes in the gasoline coating the fuel passages and acting to block gasoline flow to the engine. Also dirt particles could work their way into the fuel passages, again blocking fuel flow.

Poor engine performance, hesitation during operation, and little or no engine response to idle mixture adjustments indicates possible carburetor malfunctions. When considering the possibility of carburetor inefficiency, it is best to consider the amount of time and miles since the carburetor was last overhauled, and conditions of motorcycle usage that would effect carburetor efficiency. If a carburetor has been used on a motorcycle for approximately 3,000 - 5,000 miles, or has been used for low mileage riding for at least ½ year, then it should be considered good preventative maintenance to overhaul the carburetor. If the motorcycle is run under unusually bad conditions, such as trail or desert riding, the great quantities of dirt in the air greatly increase the possibility of a plugged carburetor. A motorcycle that operates in those conditions is best overhauled about every 1,000 or 2,000 miles. A good 'rule of thumb' for performing carburetor maintenance is to overhaul the carburetor at the same time you perform routine decarbonization--every 3,000 - 4,000 miles.

The basic method used to overhaul a carburetor is to completely disassemble it and place all the parts in a good carburetor cleaner. The cleaning solvent removes gasoline deposits, dirt, and sludge of any sort that might clog any of the passages. After the parts have soaked for a half-hour or so, depending on the quality of cleaner and the condition of the carburetor, you should dip the carburetor in a solvent that will remove the toxic carburetor cleaner and then use high pressure air to blow out the air and fuel passages. Sometimes the cleaner may loosen some dirt but it may not come out unless it is forced out by air. Also, the air will dry the carburetor parts and the carburetor can be put back together immediately.

The carburetor gives certain indications when it is not functioning correctly, and a teardown, or at least a partial teardown is required to correct the problem. Sometimes dirt can lodge between the fuel needle and its seat. This condition will cause the float bowl to flood. If this happens, the carburetor has to be torn down and the fuel needle and seat thoroughly cleaned. Also dirt can get between the throttle slide and the slide bore. The slide will continually stick and will not return to a closed position.

Periodically the starter plunger should be checked because the neoprene seal on the bottom of the plunger could possible have a small piece chipped off or a little crease could develop. Ultimately gas would leak into the chamber and get down into the venturi. The motorcycle would continually run rich. The neoprene plunger seal should be checked every time any carburetor is taken apart. This should become a standard maintenance check even though it is a very small problem that doesn't occur too often.

TROUBLESHOOTING

A carburetor malfunction first has to be analyzed as to which part is at fault before the trouble can be corrected. The malfunction could be possibly a worn out part, a part or screw that has come loose, or perhaps an adjustment is all that is needed. Carburetor malfunctions are divided into two groups to help determine the trouble--(1) a too rich mixture, or (2) a too lean mixture. Also, to help isolate the trouble, you should determine at which throttle opening this malfunction occurs. In this way, the trouble can be pin-pointed to a particular fuel/air system (i.e., idle, slow, mid-range, or high speed), the parts and passages can be examined, and the problem can be corrected.

In order to troubleshoot and make the correct adjustments on a carburetor, it is necessary for you to understand the differences in conditions of a motorcycle that is running too lean or too rich.

	SYMPTOM
A rich condition	1. rough idle. 2. blubbers under acceleration--also called '4-stroking' in a 2-stroke because an overly rich mixture acts to suppress many of the ignition strokes. 3. difficult to start. 4. gas fouled spark plug 5. black appearance in exhaust pipe.
A lean condition	1. rough idle. 2. backfires out carburetor. 3. hesitation when throttle is twisted open. 4. overheating. 5. spark plug insulator is white. 6. while maintaining one throttle opening, cycle picks up speed when choke is used. 7. runs fairly good but acts as though brake is being held on.

COMMON PROBLEMS	COMPONENT AT FAULT
Restricted gas lines	1. fuel cock 2. fuel delivery tube 3. main, pilot, needle jet, etc., plugged
Air leaks	1. loose carburetor connection 2. bent flange, or other damaged parts
Faulty parts	1. needle jet and/or jet needle are worn 2. jet is loose (usually the main jet)
Air cleaner	1. dirty cleaner 2. loose joints
Engine	1. oil seal is worn out 2. head or cylinder gasket leaks

You should pay special attention to certain possible troublespots that are "different", but account for a great many carburetor problems. These problems do not require much of a carburetor tear-down to correct them, many times an adjustment will be sufficient.

Water in the float bowl--the average rider continually cleans his motorcycle, more so now because of the availability of the 25¢ car wash. It is very easy for water to get into the fuel tank or an intake passage and be drawn into the float bowl. This water, since it is heavier than gasoline, will become lodged in the fuel passages and plug them up. The float bowl has to be removed and emptied. Also the main jet must be removed and cleared of water.

Slide sticks, causes high revving--This occurs because the detergent used in these car washes sometimes penetrates into the carburetor due to an owner directing the high pressure water and detergent directly against the carburetor. This not only washes off the fuel and oil particles that lubricate the slide, but the detergent also clings to the slide, causing the slide to stick in the bore.

Ring nut too loose (top of carburetor)--Occasionally the ring nut vibrates loose and backs off. This allows the slide to vibrate up and down causing erratic running and also provides an air leak.

Ring too tight--The throttle slide will bind up if the top ring is cinched too tight. It is not necessary to use a pliers to tighten the ring. A very satisfactory method of tightening is to place the tip of a flat-edged screwdriver against one of the raised bumps of the ring and tap the screwdriver lightly.

Loose carburetor cinch bolt--The cinch bolt vibrating loose can be a problem. The carburetor will not be securely fastened and the carburetor could pivot. This would change the float level or else allow air to be sucked into the crankcase bypassing the carburetor. If the carburetor pivots drastically, the starter jet might be held open. It should become a basic step to check the carburetor for a tight fit to the cylinder.

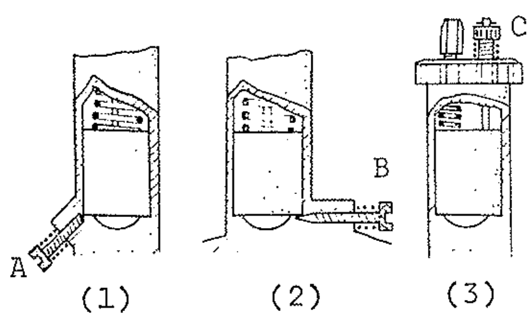
Leaking float bowl--The float bowl will occasionally leak past its gasket. If it is severe enough, it will cause starvation at the top of the rpm range. Varnish will coat the outside of the float bowl. This dried gasoline will usually be a reddish color, look for this when seeking evidence of a leaking float bowl.

Carburetors not synchronized--One of the most common problems of dual carburetor motorcycles is the problem of the carburetors not synchronized, slides not adjusted to the same height and the slides not lifting at the same time. This causes uneven running or possible one cylinder running hot. Follow the directions in the "Synchronizing Two Carburetors" section for the correct way to synchronize the carburetors.

SYNCHRONIZING DUAL CARBURETORS

When two carburetors are used on one motorcycle, the carburetors must be built to identical specifications and adjusted to operate exactly like one another at the same time. The sizes of the carburetors and the individual jet sizes are easy to check to make sure they are identical. The hardest part is the accurate adjustment of the slides so that the slides lift simultaneously. This, however, can be done in a reasonably easy step by step method as follows:

1. Back off the throttle stop screws so that both slides drop all the way to the bottom.



2. Place your fingers firmly against the slides so that they cannot move, then with the other hand lift the throttle cable on top of each carburetor to test for free play. Use the cable adjusters on top of the carburetors to adjust both cables for approximately 1/16" of free play. Regardless of the amount of free play, make them equal. At this time the slides should be close to a final adjustment. Step #3 should now only be a matter of a half-turn either way on either adjuster to complete the final adjustment.

3. There are two completely acceptable methods for this step of synchronizing the slides.

3a. Place individual fingers from one hand inside the air intake part of the carburetors until you lightly touch the slides. Take hold of the throttle grip with your other hand and very slowly turn the throttle open, then closed. This will cause the slides in both carburetors to lift. Take special note as to whether both slides start to raise at exactly the same time. If one slide starts up before the other, then make an adjustment of the cable on top of the carburetor cap. Adjust either of the carburetors to match the other. Place your fingers in the carburetors again and check once more for slide lift at the identical time. It will take a little patience, so take your time and always work toward the situation of having both slides come off their seats at exactly the same time.

3b. Place a wide angle mirror at the air intake end of the carburetors so that both carburetor slides are visible. Twist the throttle grip until both slides lift up, completely out of sight. Now begin to drop the slides until the cutaway edge of one slide just peeks into view. Ideally, both slides should begin to show at the top of the venturi exactly at the same time. Use the individual cable adjusters to adjust the slides exactly if one slide is late in following the other.

4. Screw in the throttle slide stop screws until they barely touch the slide. Screw them in a couple turns, but be sure that both slides have been raised the same distance. This will allow the engine to at least idle until all the proper adjustments can be made (see Adjustments, Idle Circuit).

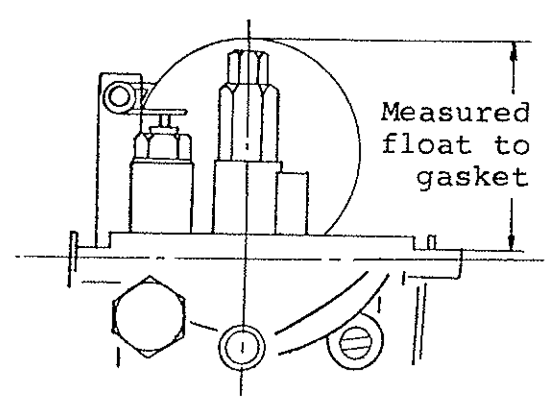
5. Adjust the throttle cable at the handle bars to allow about 1/8" free play in the cable. There should be enough free play to pivot the handle bars completely from one side to the other without all the cable slack being taken up and the slides accidentally lifted. Also there should be roughly 1/32" free play at each cable adjuster right at the carburetor, to avoid the same situation.

ADJUSTMENT

Many times a carburetor malfunction can be corrected by an adjustment to one of the fuel/air supply circuits. This might include adjustment of an air bleed screw or it might require a change of one of the jets to a different size. This section will cover the different circuits, according to throttle opening, the parts involved, and how a lean or rich mixture can be changed to achieve the correct mixture.

Float Adjustment: First note the float is pre-set at the factory. Do not concern yourself with a float adjustment unless it is believed that someone has already tried to readjust it and has changed the float setting. Under normal circumstances, the float need not be touched unless it is defective . However, if the float has been bent in some manner use this procedure to correctly adjust the float.

Turn the carburetor up-side-down and tilt the carburetor until the float pivots against the spring-loaded fuel inlet needle. Make sure the needle is firmly located against its seat by gently pushing against the float assembly, then letting it spring back until the float 'adjustable tang' is lightly touching the needle. To obtain an accurate setting, the spring-loaded pin in the back of the fuel needle should not be forced in at all by the float. Next measure the distance from the top of the float to the float bowl gasket surface. Check with the individual service manuals for the proper float height of the carburetor in question. If the float height is not correct, change it by bending the float tang that is touching the fuel needle. Absolutely do not make float adjustments by bending the individual floats. Always bend the adjustable tang. If both floats are measured and found to be unequal, then it is permissible to bend the individual float arm to get both floats level with each other, but not to set the float level.



Idle Circuit--0-1/8 throttle opening: The idle circuit has two adjustments, the pilot air screw and the throttle slide stop screw. The 'pilot air screw' is usually located on the side and toward the front of the carburetor (air intake end), or in the case of the rotary valve models, it is located right inside the venturi opening. Run the screw in to cut down the air supply and create a rich mixture, screw it out to lean the mixture. The factory has compiled a list of recommended pilot air settings. These recommendations are quite correct when used on a stock motorcycle and there is no need to make any other adjustments with the idle air screw. These recommendations are bench settings, and if a change is required, then this indicates a malfunction or misadjustment.

If the motorcycle in question has been modified in any manner that might affect the idle mixture, then this next procedure should be followed. Start at the factory recommended setting. Alternately turn the pilot air screw in, then out. Stop at the setting that gives the highest and smoothest RPM. However, the idle mixture that provides the most RPM tends to be slightly lean. Cure this weakness by turning the pilot air screw back in 1/8 - 1/4 turns.

The next step is to set the actual idle speed. This can be done by adjusting the throttle slide stop screw.

Adjusting the idle speed on a twin cylinder machine is accomplished by first starting the engine and allowing it to warm up to operating temperature. Next, pull one spark plug lead off. Set the idle adjust screw high enough to allow the machine to run on one cylinder.

With the engine idling at 800-1100 RPM on one cylinder, continue to lower the idle speed very slowly, until the engine just dies. Repeat this procedure on the opposite cylinder. Hook up both spark plug leads and start the engine. This procedure will produce approximately 1500 RPM idle in the average twin. If a customer prefers a different idle speed, then adjust each idle screw in or out equally to achieve the desired amount of RPM. Should doubt exist, a final check of the idle balance can be achieved by partially blocking the exhaust from each muffler and listening for erratic firing that will indicate an imbalance between the two carburetors.

Mid-Range-1/4-3/4 throttle opening: The mid-range fuel/air system is controlled and adjusted by the venturi (air supply), and the needle and needle jet (fuel supply). The air supply is regulated by throttle opening. The fuel supply can be adjusted to supply a leaner or richer mixture if needed. The needle has five (5) grooves in the top for clip location. Normally the clip is snapped into place at the second or third (middle) groove. If the motorcycle does not run correctly at this setting, then continue to move the clip up or down, one groove at a time, until the carburetor does function correctly. Remember, placing the circlip in the top groove will cause the needle to drop further into the needle jet, creating a leaner mixture. The lower the clip is placed, the higher the needle is held in the needle jet. This allows a richer mixture to exist.

NOTE: Our carburetor servicing specifications list needle settings in this way; 2 stage, 3 stage, etc. "Stage" means the groove for the clip setting, so 2 stage actually means 2nd groove. Always count the grooves from the top (top groove is #1 stage).

High Speed--3/4-full throttle: The main jet controls maximum rpm carburetor mixture. If you are working on a "stock" bike, just check to make sure the factory specified main jet is there. This normally will give the correct amount of fuel for the amount of air entering the engine. The main jet has a size number stamped on it. The main jet sizes are stamped in steps of five (5) up to a hundred (100) (i.e., 20, 25, 30, 35, etc.). The sizes over a hundred (100) are listed in steps of ten (10) (i.e., 110, 120, 130, 140, etc.). If, for any reason the main jet size is to be changed, do so in single steps.

a. Elevation and main jets: The higher the elevation, the less atmospheric pressure there is, so the mixture becomes richer. The main jet should be smaller than standard as the elevation is increased.

(Note: This is not a hard and fast rule. Some riders can use standard main jets at high altitudes without any difficulties. However, if a motorcycle does run rich at high altitudes, then use the scale below as a rule of thumb.)

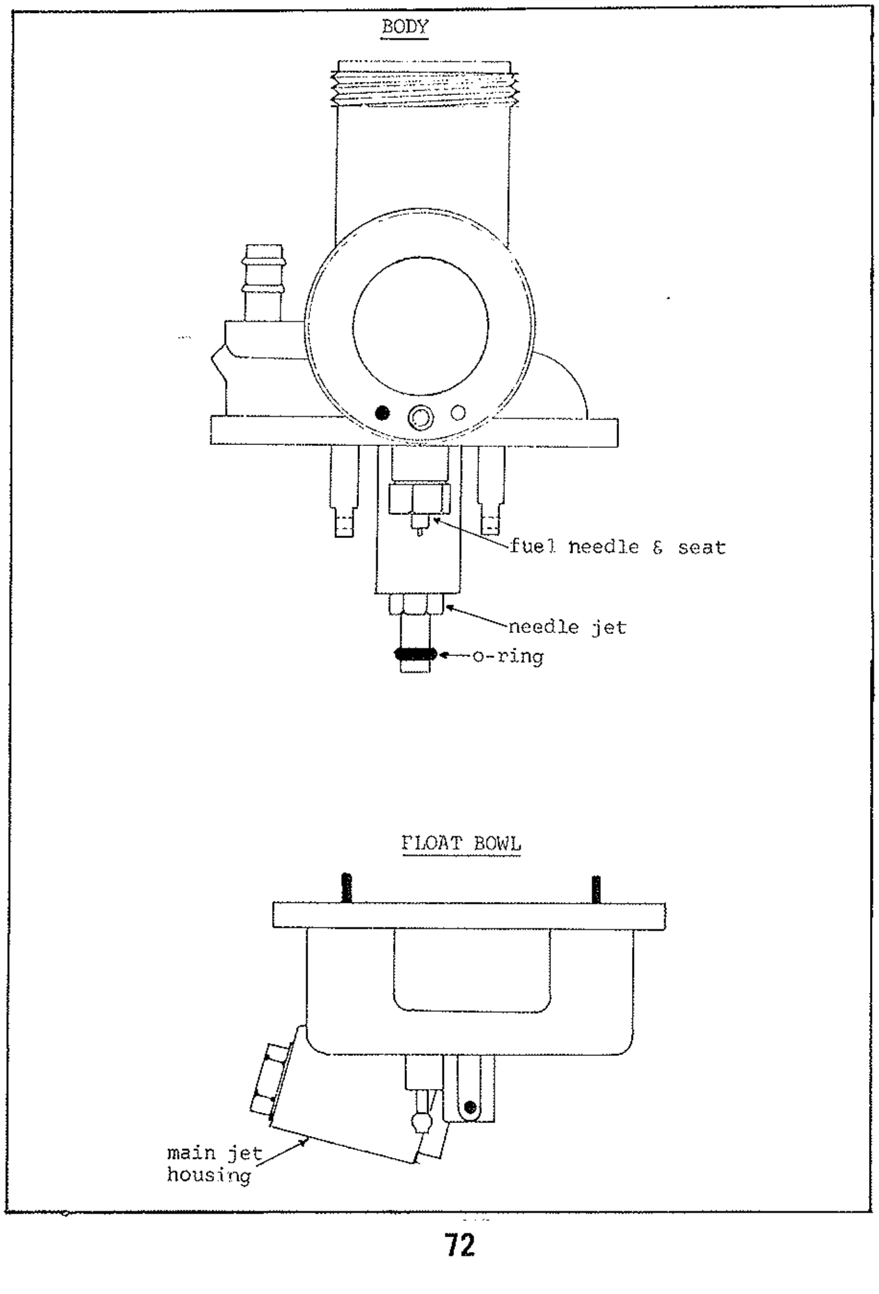
Up to 3,300 feet.............Standard size
3,300-6,600..................Standard size less 5%
For every 3,300 feet increase, the size should be reduced 5%

b. Air cleaner and main jet-When running a motorcycle without an air cleaner, a larger main jet should be used because the mixture is leaned out and eventually the engine overheats.

c. Muffler and main jet-When removing the inner cylinder of the muffler (baffle) or replacing with a racing muffler, the main jet should be larger.

The DT-1 carburetor modifications are restricted to: The main jet location, new removable type needle jet, and new type float design. The main jet is now housed in the side of the float bowl, and can be removed and changed without removing the float bowl. Remove the side located banjo bolt and you will find the main jet screwed into the end of it.

The needle jet and fuel nozzle are now two separate pieces and the needle jet size can be changed without removing the entire assembly. Also note that the new type needle jet has a rubber 'o-ring' located at the bottom. It is essential that this o-ring be in good condition as it acts to seal the main jet-needle jet passage so that fuel cannot bypass the main jet. Replace the o-ring if any part of the rubber has a permanent crease or pit in it. An indication of a defective o-ring would be constantly rich mixture condition, no matter how many main jet changes are made.

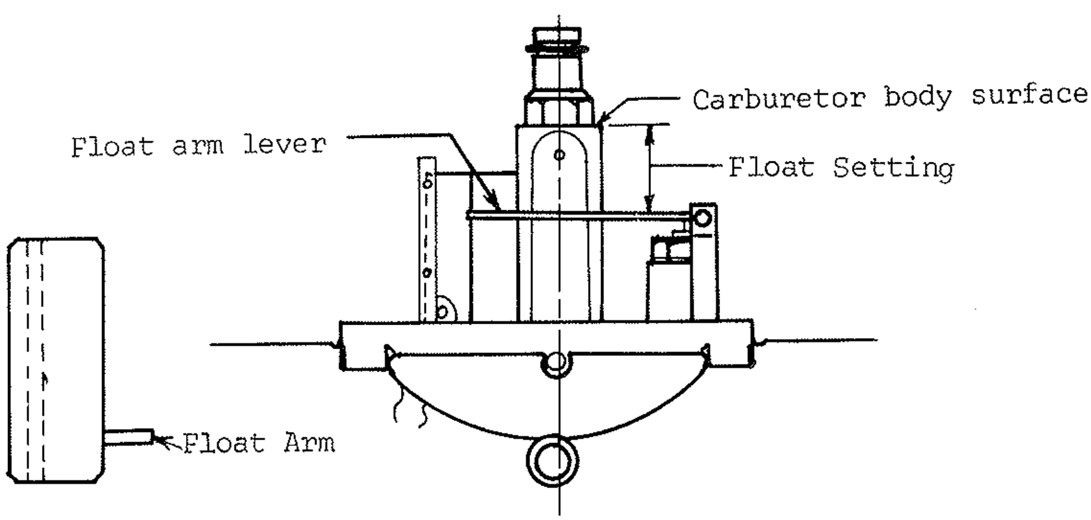


The new fuel float has been used because it is less susceptible to fuel level variations caused by vibration and jarring of the motorcycle. The floats are independent of one another and located on pins. The pins restrict the floats to an up and down movement, thereby greatly decreasing fuel level variations due to the motorcycle being tilted on an angle while being ridden.

It should be noted that the floats be installed with the metal float arm toward the bottom of the float bowl.

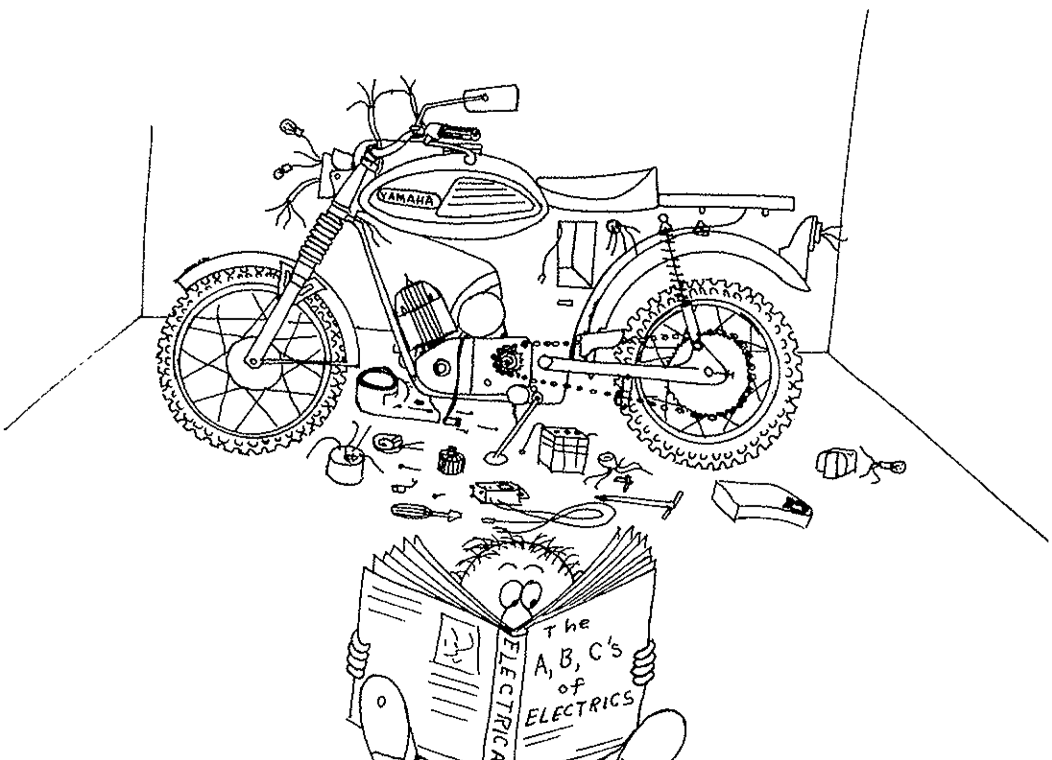
The 'float level' setting is accomplished quite differently than on other Mikuni carburetors. The floats themselves are not used when setting the level.

Remove the float bowl and turn the carburetor up-side-down. If you look close you will see that the adjustable tang of the float arms lightly rests against the spring-loaded fuel needle. Measure the distance from the needle jet housing surface to each of the float arms. First make sure that each arm is equal in distance; if not, adjust one to match the other (very rarely are they not equal). Next, see if the distance just measured equals factory specifications. A vernier caliper is an ideal tool to use for measuring the float level. The only acceptable place to adjust the overall float level is at the 'adjustable tang'. Bend the tang up or down, depending on the change desired.



YAMAHA

ELECTRICAL



ELECTRICAL

ELECTRICAL

I. GENERATOR (Models: L1, DS3(C), DS6C, entire 'M' series, entire 'R' series)

A. D.C. Dynamo with self-exciting fields

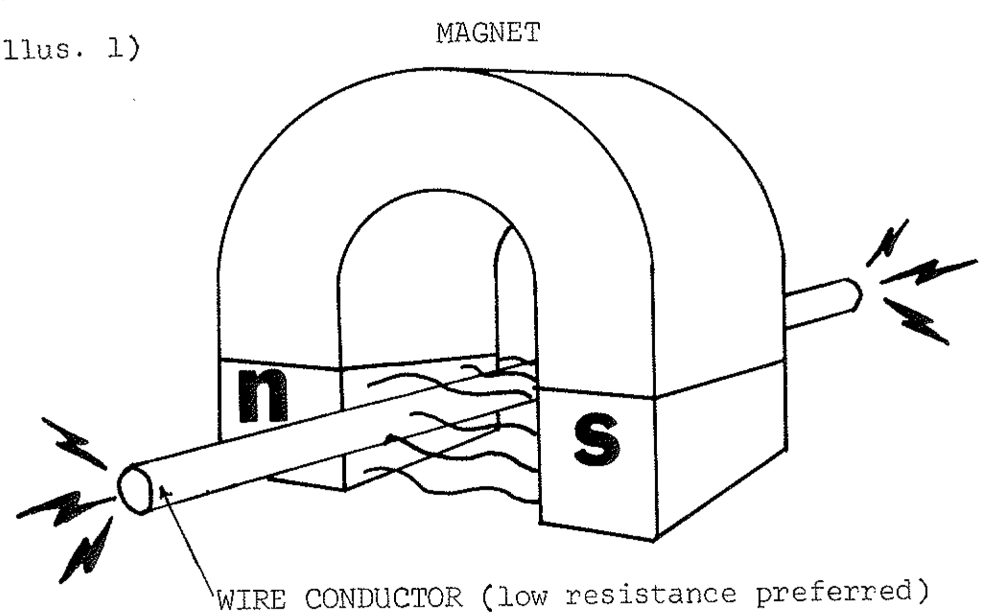
1. Principle: A magnet is the first essential part of a generator. The generator could not be possible without it. As shown in Illustration #1, there are invisible magnetic lines of force that exist between the poles of the magnet. (The magnetic field, although invisible, can be seen by placing a piece of paper over a magnet and then sprinkling iron filings on the paper. The iron filings will gather along the magnetic lines.) It is these magnetic lines of force that are used to produce voltage.

All magnets have a north and south pole. In the case of a horseshoe magnet, the poles are parallel to each other and separated by an air gap. Between these poles there exists an invisible magnetic force field. A voltage potential can be produced in any wire by having it move through the magnetic lines of force.

The voltage generated in this simple way can be increased by using a stronger magnet, creating more magnetic lines for the wire to move through, or by using more wire, or by moving the wire faster in the magnetic field, thereby cutting more magnetic lines of force.

Imagine the generator as one piece of wire moving through one magnetic line of force at one rpm. Increase any one of these three items and you'll increase the voltage induced in the wire.

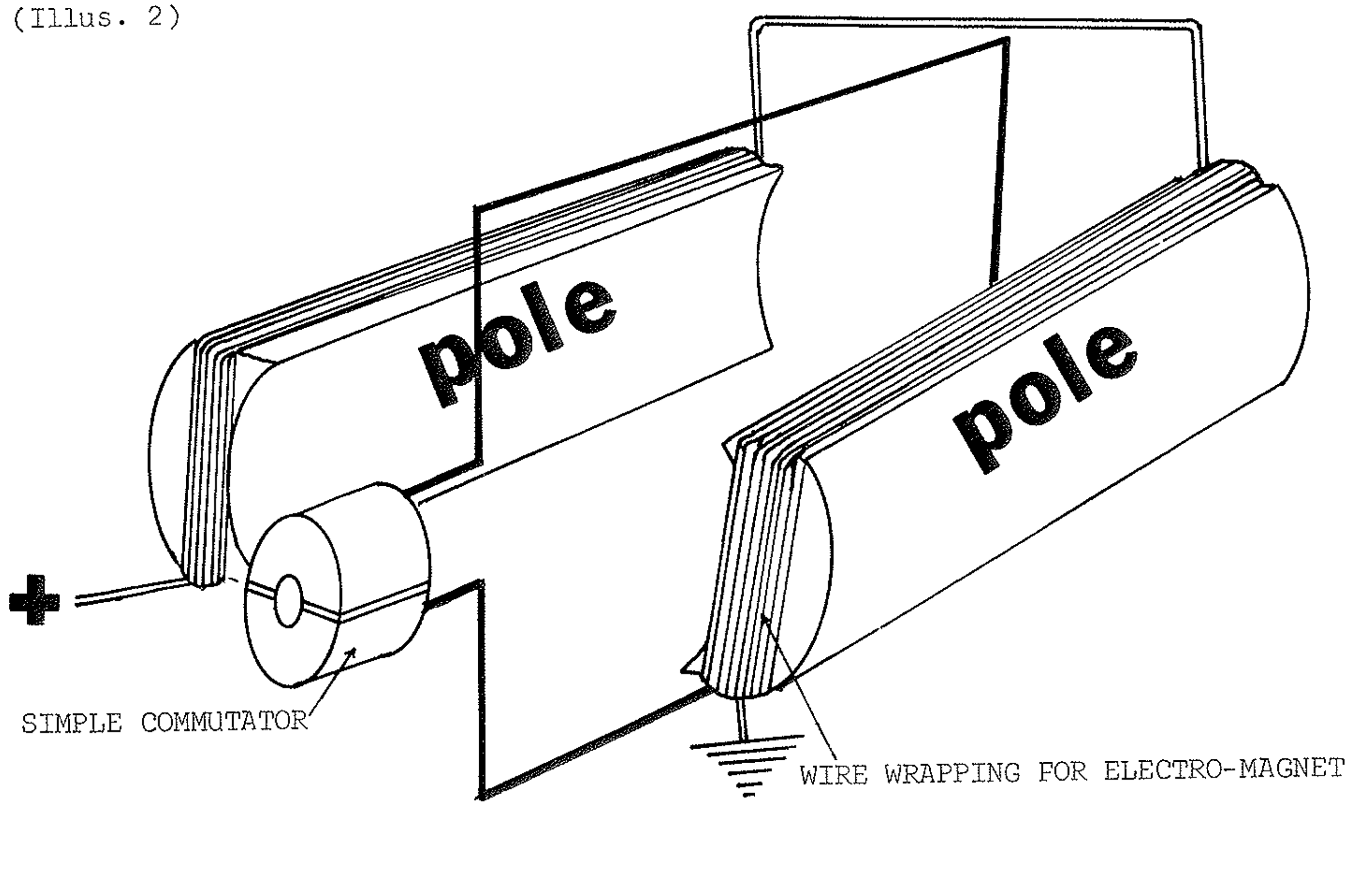
(Illus. 1)



1. <u>Principle</u>: (continued)

A generator uses only the ends (poles) of the magnet when producing voltage. In the case of a generator, the poles are electro-magnet ends, as the poles have many windings of electrically charged wire wrapped around them (See Illus. 2). A strong magnetic field exists between the poles. The wire that cuts through the magnetic field is in the shape of a loop. The ends of the loop are attached to separated metal segments (See Illus. 2). The separated metal segments, no matter how many are used in the generator, make up what is called the "commutator". (It should be noted that the metal segments are insulated from one another by placing solid mica between them.) The wire and commutator combined make up a simple armature. An improved armature can be had if more wire loops are added with corresponding metal segments on the commutator. The more loops cutting across the magnetic field, the more voltage it is possible to generate. The armature is next given an iron core around which the many loops of wire are wrapped.

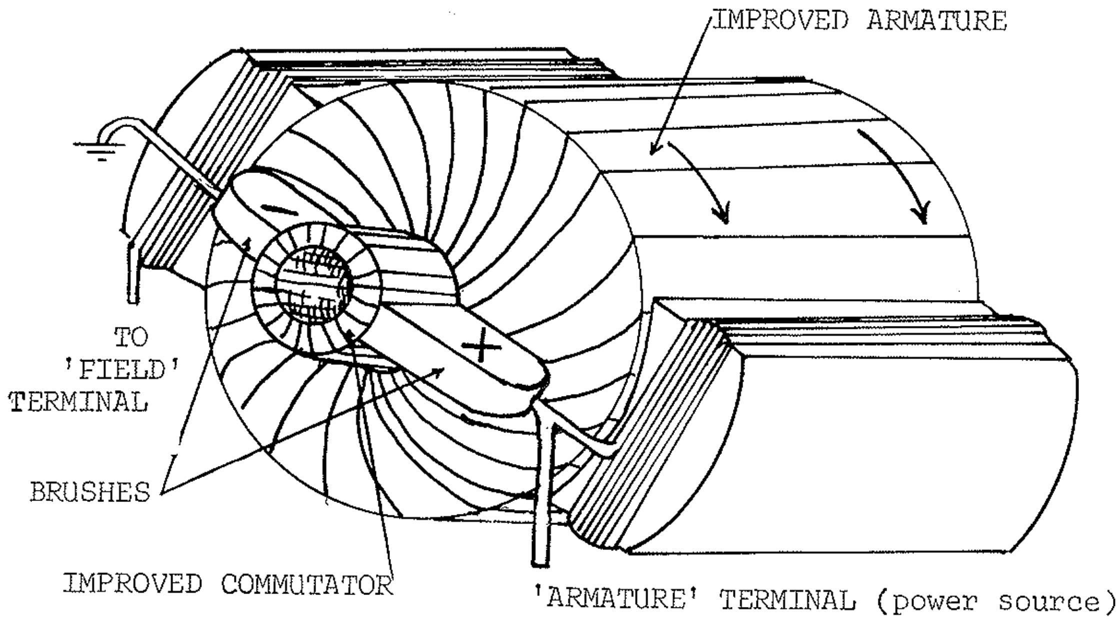
(Illus. 2)



1. <u>Principle</u>: (continued)

The generator produces voltage to maintain its own electromagnetic field. The stationary carbon brushes slide on the commutator and pick up the generator voltage. The voltage is passed into the field coils from the positive (+) brush (See Illus. 3).

(Illus. 3)



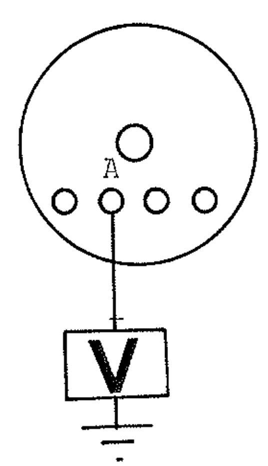
2. Maintenance

NOTE: The Yamaha D. C. generating dynamo is designed as two main components. The first is the armature, consisting of the separated commutator segments and the many loops of wire that cut through the magnetic field. The second main component is the yoke; the housing that slips over the armature. The inside of the yoke houses the electro-magnetic poles; the "field winding".

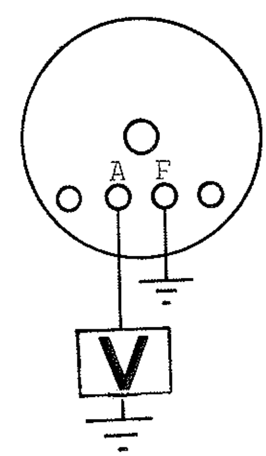
A. Troubleshooting:

First determine that there is actually a failure in the generating circuit, not in the complaining rider's inexperienced mind. This situation can be proved by using a voltmeter to check for voltage output. A quick test can be made by hooking the red lead of the voltmeter to the armature terminal (A) and ground the black lead (See Illus. 4). You should get a voltage reading with the engine running approximately 2,500-3,000 RPM. A no voltage reading will indicate a charging circuit failure. The charging failure should be further isolated by removing the generator (electrically) from the rest of the wiring on the machine. This will "isolate" the generator from such problems as a bad voltage regulator.

(Illus. 4)



(Illus. 5)



2. Maintenance: (continued)

To check the generator output disconnect the field wire (terminal F) and armature wire (terminal A). This will isolate the generator from a faulty voltage regulator or faulty wiring. Use a jumper wire to ground the fields. Hook the wire from terminal F to a good ground. Hook a voltmeter to the armature, red lead (+) to terminal "A" and black lead (-) to a good ground (see Illus. 5) Start the engine and run to approximately 2,500 RPM. Any higher RPM's and the charging circuit can be damaged.

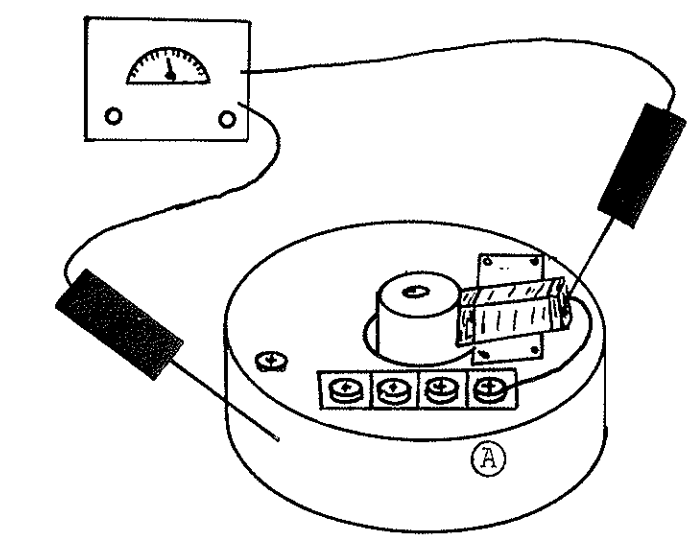
If there is a voltage reading roughly the rated voltage output of the electrical system (6 or 12 volts), then the generator is functioning and the trouble is located elsewhere. However, if very little or no voltage is being generated, the generator can then be considered the troublespot. Further checking of the generator is required to determine exactly what part of the generator is not functioning.

There are specific checks that can be made on the generating dynamo before any parts are removed.

1. Inspect all the wire connections to be sure they are tight.
2. The carbon brush-
   a. Remove the brushes and measure their length. Replace them if the length is less than the specified minimum. Also it is a good practice to replace the brush springs whenever the brushes are replaced.

   b. Insulation of the positive brush--The positive brush is located on an insulating plate. Use the electro-tester to check for proper insulation between the brush holder and the yoke (See Illus. 6). The brush holder could be loose or carbon dust could be shorting the holder. Lift the negative brushes off the commutator segments before making this test.

(Illus. 6)



3. Carbon dust, oil, or any other contamination could be shorting a part of the yoke assembly. If this is suspected, remove the yoke and thoroughly wash it with solvent. Use a brush to get into all the corners. Blow out the yoke with air to finish the clean up.

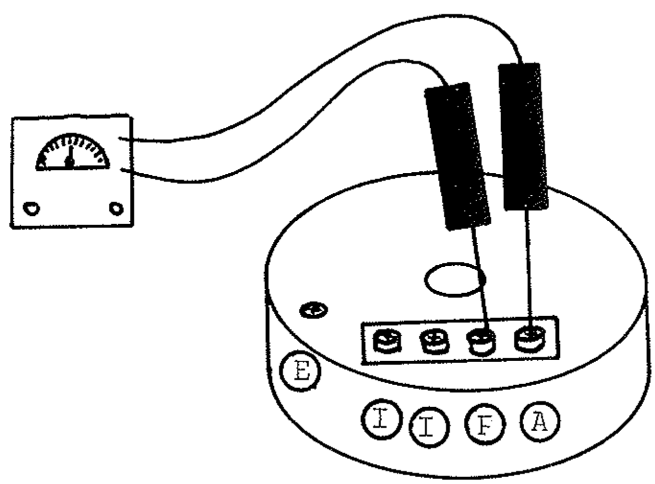
Check for continuity of the field windings--This is done by hooking up the two electro-tester leads (meter set on continuity) to the armature and field terminals (A & F) (See Illus. 7). Continuity must exist.

a. Make sure the terminals are tight.

b. Lift the positive and negative brushes off the commutator.

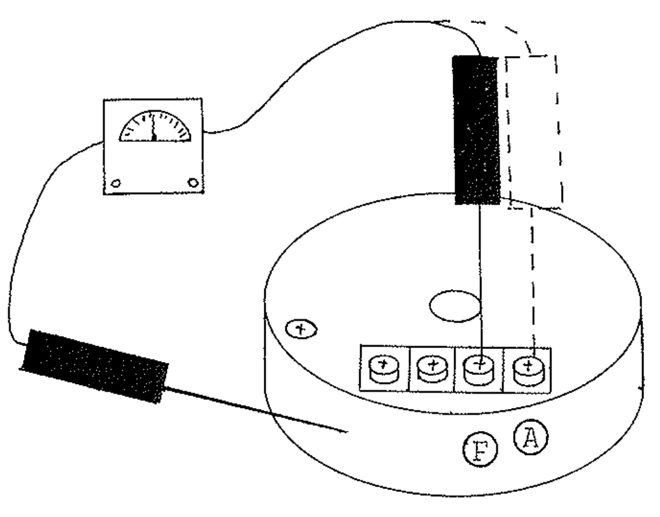
c. Any resistance between these two points will be the field coil resistance and usually averages 4-8 ohms.

(Illus. 7)



Check the insulation of the field windings--Set the electro-tester on insulation (million ohms). Touch one lead to the yoke, and the other to first the armature terminal (A) and then the field terminal (F) (See Illus. 8). A reading of "infinite resistance" to 3 meg-ohms means that the field windings are good. The field windings are shorting to the yoke if the resistance is less than 3 meg-ohms (1 meg-ohm is less). Cleaning with solvent is again recommended to eliminate the possibility of carbon or dirt being the cause of the short. The other possible cause is the windings actually touching the housing.

(Illus. 8)



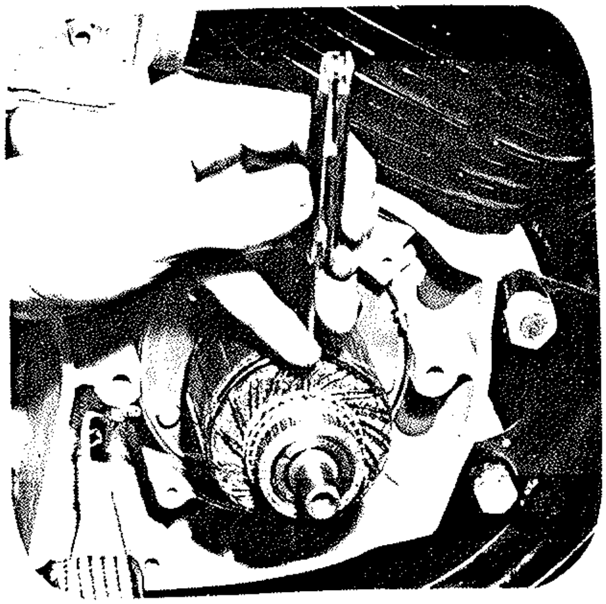
Note: In the foregoing tests, the armature, (A terminal); fields, (F terminal) and motor wires (M terminal if present), from the voltage regulator must be disconnected.

Armature

The second main component of the generator assembly is the armature. If the previous service checks failed to show a malfunction, remove the yoke assembly and perform the following armature service checks:

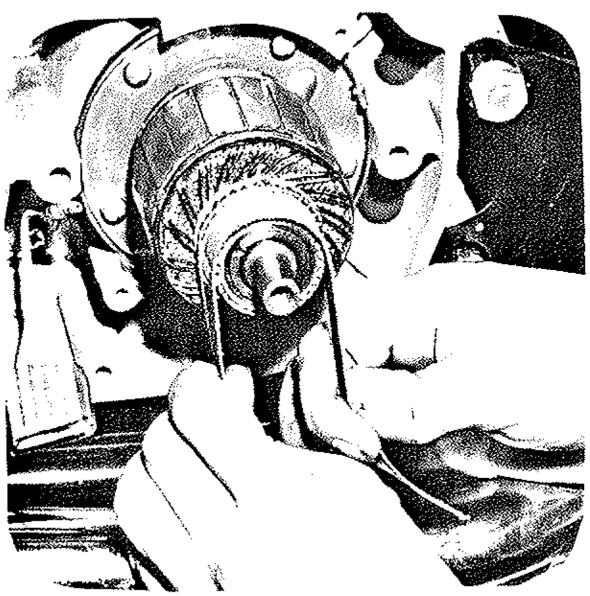
1. Carbon in the mica gap--completely clean the gaps between segments down to the mica (See Illus. 9). The carbon must be removed because it is a conductor, and the bars must be insulated from each other. Also check depth of the mica undercut against factory specifications. Use a hacksaw blade, screwdriver or knife to remove the mica to the proper depth.

(Illus. 9)



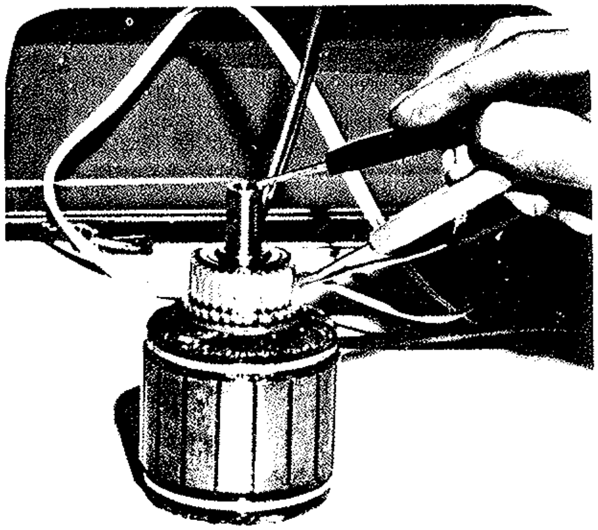
2. Commutator dirty or rough--A clean smooth surface is needed for good carbon brush contact. If a dirty condition exists, use a piece of fine emery and lightly but evenly touch up the commutator (See Illus. 10).

(Illus. 10)



3. Armature insulation--There should be absolutely no reading between the commutator segments and the core. Use the meg-ohm scale (insulation) of the electro-testor (See Illus. 11). The scale should read infinity, showing a complete open circuit between the commutator and the core. Be sure to check all the separated commutator segments.

(Illus. 11)



4. Continuity between the separated segments--Test each commutator segment with the others. Even though the segments are separated from each other, they are still interconnected, and continuity has to exist between them all or the armature is bad.

5. A final test to apply to the armature, in case of improper or no voltage output, is to place the armature on a 'growler' and check for an internal short in the copper armature windings. This small testing machine is found in most automotive electrical shops and would be good to have in a motorcycle shop.

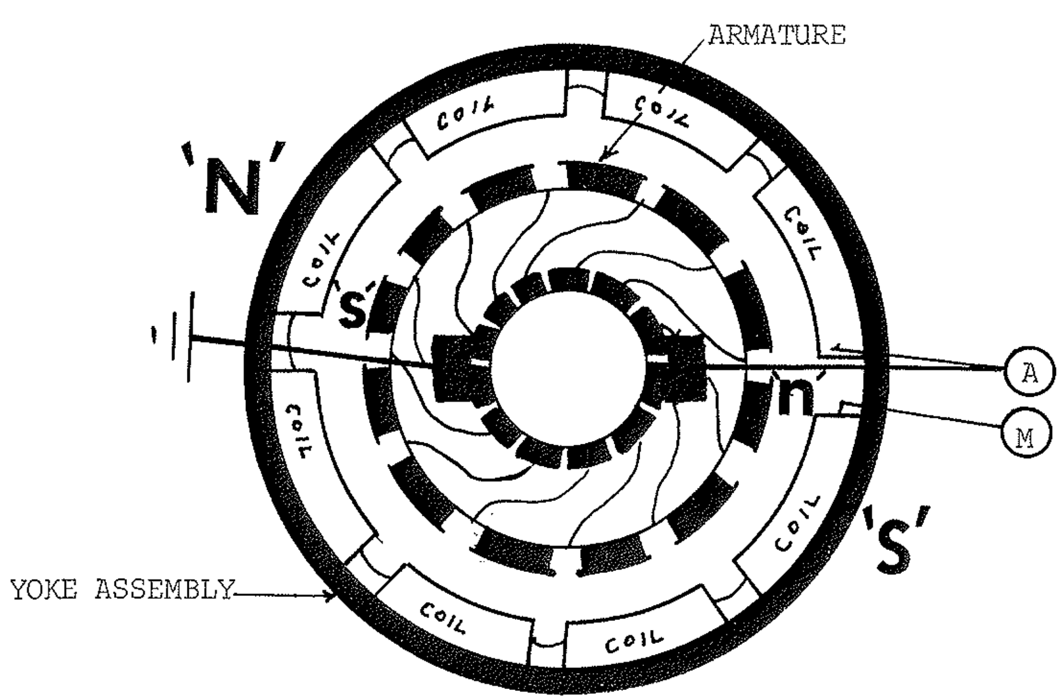
   The purpose of this tester is to create a magnetic field. The armature is placed in the V-shaped top of the tester, right in the midst of this electromagnetic field. With the growler turned on, the armature resting in the V-type cradle, and a hacksaw blade held over the armature, the armature is then rotated. If all the armature windings are insulated and not broken, there will be no magnetic attraction at all. If, during rotation, the armature develops a magnetic pull and tries to pull the hacksaw blade down, then it is very likely that two or more of the windings are shorted together, due to melted or worn insulation. Probably these wires are not shorted to the armature core because this situation would have showed up when an insulation check was made between the core and the commutator segments.

B. Starter-Generator Dynamo (Models: U5E, G5T, L1E, L5T, AT1, CS1(C), DS5)

1. Principle: The starter-generator dynamo is equipped with two separate field coils; one for the generator, the other for the starting system. They share a common armature. The old type yoke assembly has a total of eight (8) poles with two types of windings alternately spaced around the yoke. The new type also has eight poles but is different in that the high amperage starter windings are wound right over the thin wire generator windings. For ease of illustration, only the starter coils are shown (See Illus. 12). A complete explanation of the generator circuit can be found in the immediately previous section. This section covers the starter system only.

Current is sent into the starter windings. This sets up a magnetic field ("N"-"S" poles as example). Also current is sent into the armature windings through the brush. This sets up a magnetic field surrounding the armature ("s"-"n" poles). Operating on the magnetic principle that opposites attract, the "N" pole of the field windings attracts the "s" pole of the armature windings. Also the "S" pole of the field windings attracts the "n" pole of the armature windings. The poles of the field windings and the armature windings are so placed that there is a constant attracting force through the entire rotation of the armature. The armature has to rotate since the field windings, which are attached to the yoke assembly, can't move. The engine is rotated because the rotating armature is attached to the end of the crankshaft.

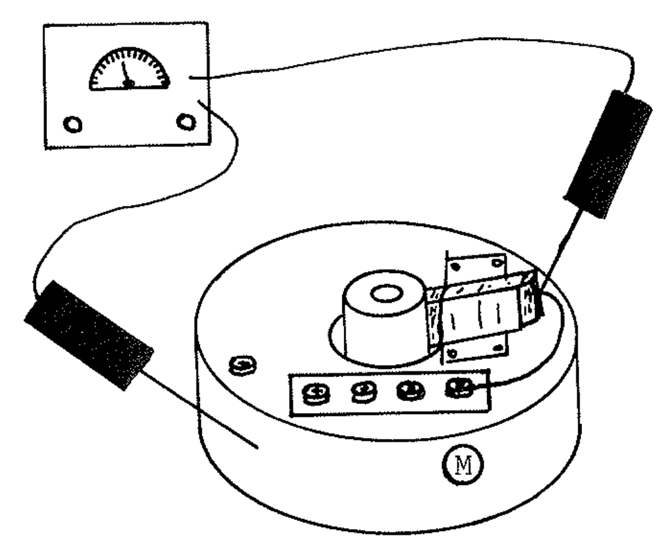
(Illus. 12)



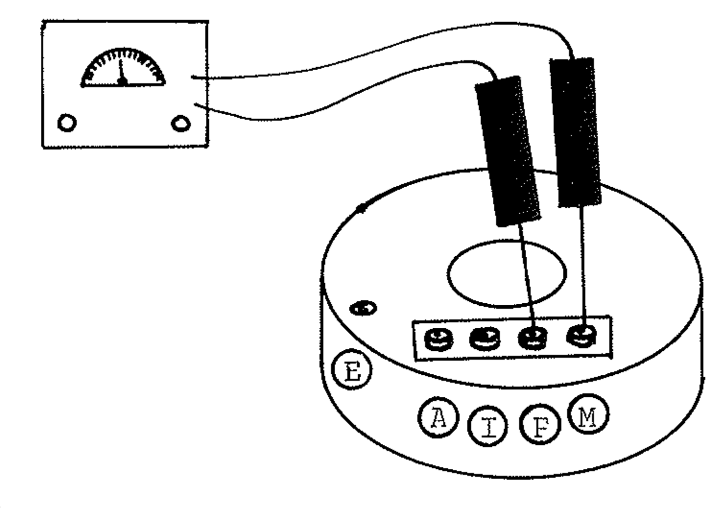
2. Maintenance: Checking and repairing the dynamo starter action is similar to the generator. The old model starter dynamo has its own carbon brushes and starter coils. The newer models simplify the starter construction by using the generator brushes to magnetize the armature, eliminating an extra set of brushes. To check the brushes and starter coil, the following steps are recommended.

a. Brushes--Check the positive brushes for insulation between the yoke and brush (See Illus. 13). If there is no insulation, check the brush holder and terminal. Remember to remove the negative brush(s) from the commutator segment surfaces.

(Illus. 13)



(Illus. 14)



b. Starter coil--Remove the wire harness (wires coming from the voltage regulator). Lift the positive brushes off the commutator segments. Check for continuity between the "M" terminal and the "A" terminal. No continuity indicates a broken motor winding. Next, remove the heavy motor winding wire from the positive brush terminal next to the "A" terminal on the yoke terminal assembly. With the electro-tester on "insulation" check for leakage between the field and motor windings. (See Illus. 14). NOTE: On some models the fields and motor windings are tied together internally. If this is the case, measure the resistance between the "M" and "F" terminals. As you will be measuring in series between these two circuits; any reading less than the exact value for the field windings will indicate an internal short between the two.

Lastly, with the heavy motor wire still disconnected from the positive brush holder measure between the "M" terminal and ground. Any resistance measurement less than 3 million ohms indicates a shorted motor winding.

C. A.C. Generator **(Models: entire 'AS' series)**

1. Principle: The alternating current generator consists of a six pole permanently magnetized rotor that rotates inside the stator (yoke assembly). The rotor's magnetic field is constantly reversed as the permanent magnet is revolved. The windings in the stator pick up this constantly changing polarity as alternating current and channel it to the rectifier. The rectifier then changes the A.C. to D.C. output.

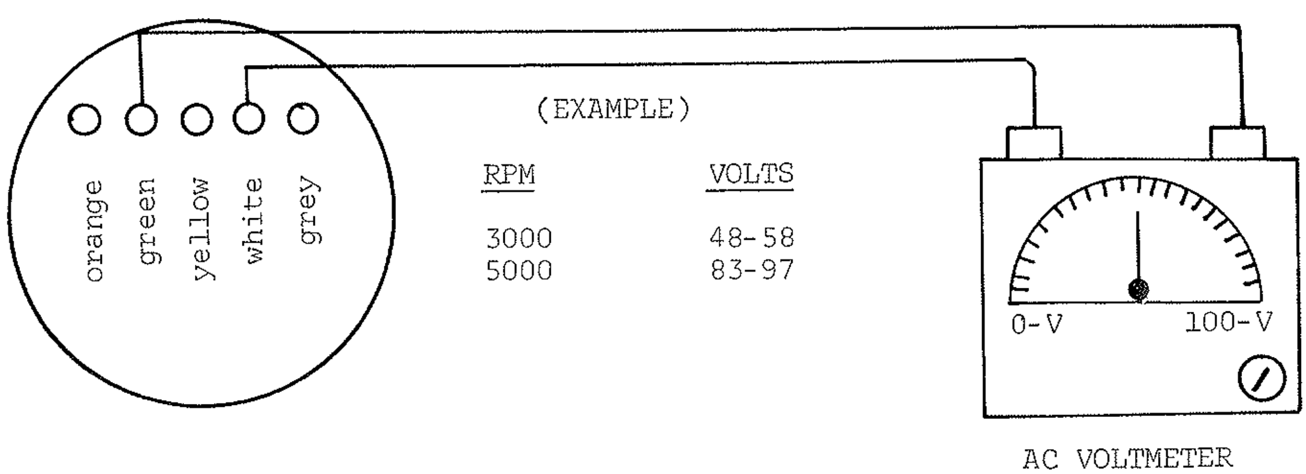
   The alternator dynamo operates more simply and efficiently than the D.C. generator and the starter-generator dynamo. This is because of the simplified construction (less parts), more durability, and less adjustments (no regulator is needed because of balanced output design).

2. Maintenance:

   a. No load voltage check (daytime riding)

   1) Disconnect the yellow, green and white wires from the stator (Yoke) assembly (See Illus. 15).
   2) Connect A.C. Volt tester (100 V) to the green and white leads on the stator. Start the engine. The volt meter reading will be output to the ignition system, charge for the battery, horn and brake light. (daytime riding).
   3) UNDER NO CIRCUMSTANCES should the battery be disconnected from the electrical system during operational tests. Under certain conditions this can result in a 400v(+) surge throughout the system.

(Illus. 15)

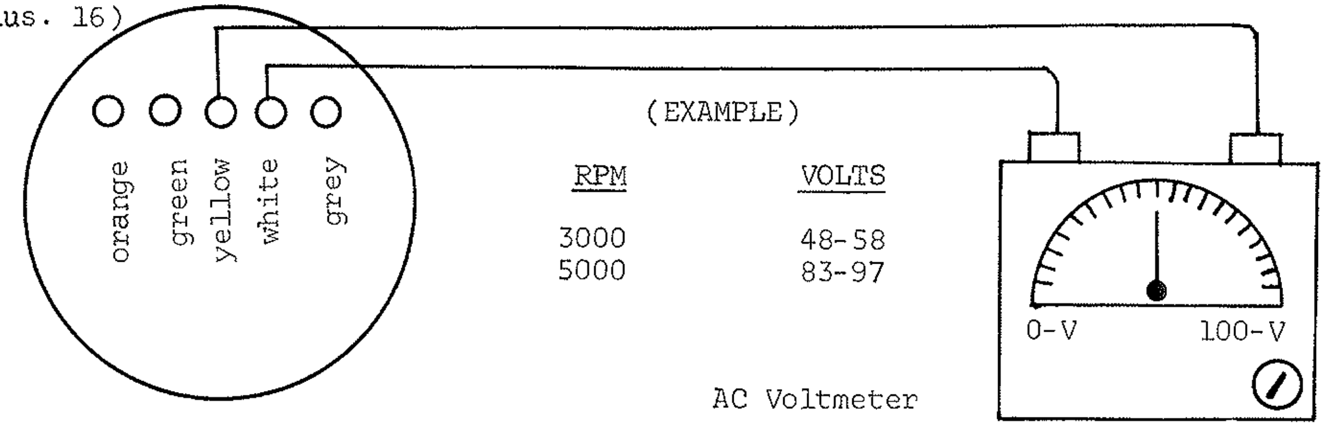


(EXAMPLE)

RPM	VOLTS
3000	48-58
5000	83-97

b. No load voltage check (nighttime riding).
Same procedure as "no load voltage check" (daytime riding) except connection of Voltmeter leads. Connect voltmeter to white and yellow leads on stator (See Illus. 16). Start the engine. The voltmeter reading will be for the ignition, horn, battery charge, headlight, taillight, brake light and instrument lights. (nighttime riding)

(Illus. 16)

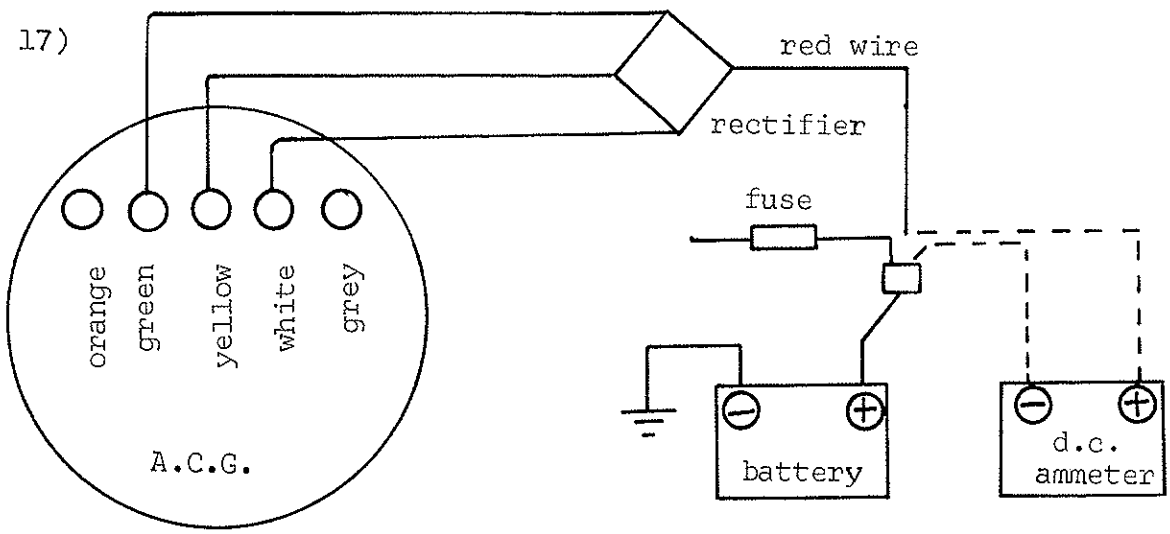


(EXAMPLE)

RPM	VOLTS
3000	48-58
5000	83-97

c. Amperage Output Check (See Illus. 17). First pull the red rectifier wire out of the connector. Then hook up the positive (+) lead of a D.C. ammeter to the red wire. Hook up the negative (-) lead of the ammeter to the connector. The amperage reading that is observed at the specified RPM range is the total amp output of the generator.

(Illus. 17)



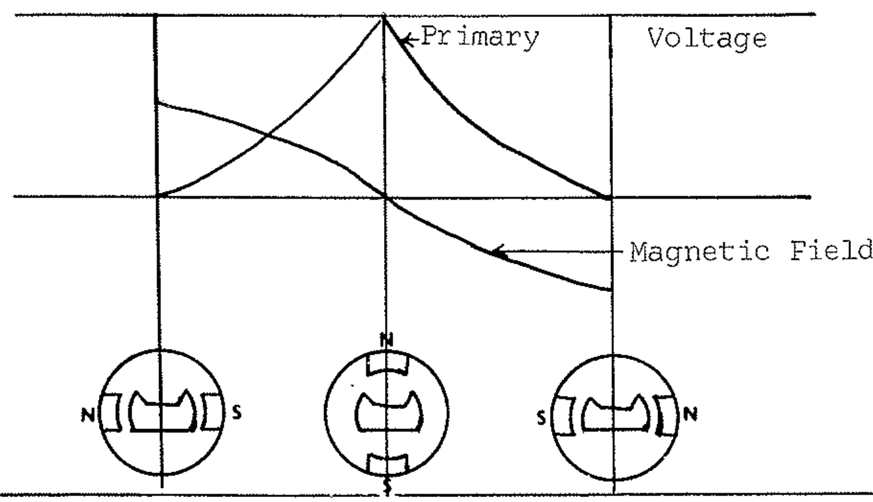
RPM	Day Switch	Night Switch
3000	2.8 ± 0.5 A	6.7 ± 0.5 A
5000	3.2 ± 0.5 A	7.1 ± 0.5 A

D. Magneto (Models: U5, J1, J2, G1, G5S, AT1M, CT1, DT1A, DT1B)

1. Principles:

a. Ignition - A magneto produces A.C. current by revolving a permanently magnetized flywheel around a coil. (See Illus. 18). This is very similar to the A.C. Generator and its method of producing A.C. current through the use of a rotor and stator (see A.C. generator; principles). The flywheel's rotating magnetic field cuts across the primary ignition coil windings. An A.C. Current is induced into the primary coil by the constantly reversing magnetic field. The primary current produced then travels through the points and condenser, secondary coil, and plug.

(Illus. 18)



b. Lighting - Electricity is produced in the same manner as above. This electricity is used for lighting or charging. The lighting coils are also located in the magneto assembly and share a common magnetized flywheel with the ignition coil. The electricity (no load voltage) that comes out of the light coil will rise with increased flywheel revolutions. When this voltage is connected to a load with the light coil inductance, the resistance to AC will increase. This action is the basis of regulation of voltage. When used for charging the battery, this current first passes through the selenium rectifier and is changed to D.C.

2. Maintenance:

a. Check by external appearance for the following conditions:

1) Wire connections are correct and secure.

2. Maintenance: (continued)

2) Oil and water spots. Clean magneto.

3) For damaged or uneven points of contact breaker. Replace or use fine sandpaper to make the contact points even.

4) Weakened condition of the magnets in the flywheel. When the ignition coil, contact breaker and condenser are good, dim lights and a weak spark usually indicate a weak magnet in the flywheel. Replace the flywheel. The magnet in the flywheel could be recharged with magnet recharger.

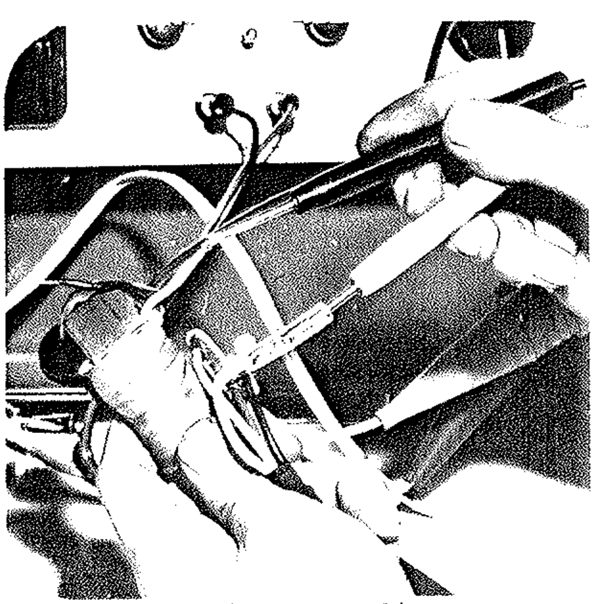
5) The ignition coil and light coil could be burnt out from excessive heat. A visual indication would be burned insulation. If so, replace.

6) Check whether the flywheel and armature are touching or show "rubbed spots". If so, the crankshaft is eccentric or the diameter of the coil pole is too large.

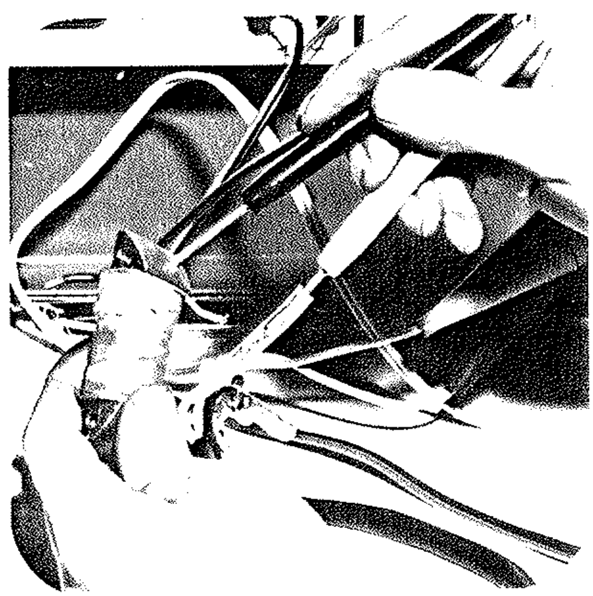
3. Electro Tester:

a. Light coil - Remove. All three wires have continuity with each other and with the core since they are all inter-connected and grounded.

b. Primary Ignition coil - The coil is comprised of a single wire wrapped many times around a metal core. One end of the wire is soldered to a common ground (with the lighting coil), and the other end leads to the ignition coil. Continuity should exist between the two leads coming out of the primary source coil. This can be checked by hooking up the two leads of the ohmmeter (set on 'continuity') to the two coil leads (See Illus. 19). Next, remove one tester probe from one of the coil leads and touch it to the core (See Illus. 20). This should show no continuity. If there is continuity, it indicates that there is a defective internal ground.



(Illus. 19)



(Illus. 20)

II. REGULATOR

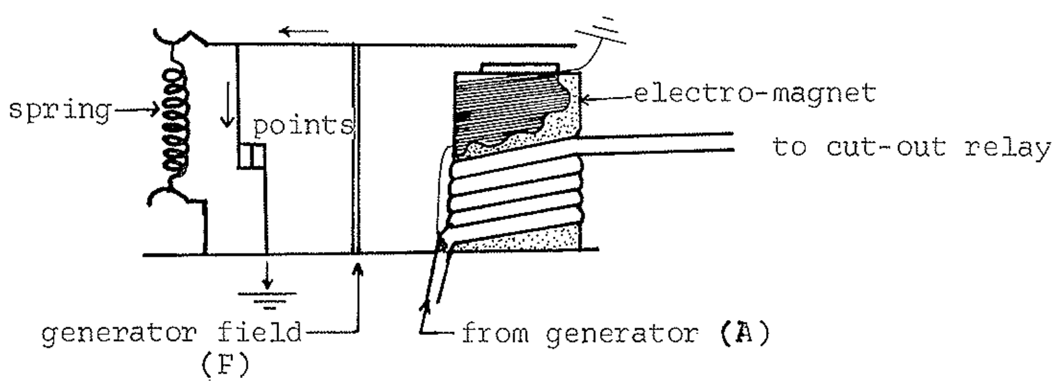
The function of the Yamaha DC generator is to produce high voltage at low RPM. However, as engine speed rises, the generator's output also rises. As a result, the voltage output has to be controlled in order to protect the charging and lighting system from voltage fluctuations. This is the reason for the voltage regulator relay.

The regulator actually consists of two relay switches enclosed in a single case. One relay is the voltage regulator and the other is the cut-out relay. The overall function of the regulator relay is to control the voltage in the field circuits, to match consumption needs of the lights and battery, thereby controlling the output of the generating system.

A. Voltage Regulator Relay

Principle: The voltage regulator relay controls voltage to the generator's field windings. At low RPM, the electromagnet (See Illus. 21) in the regulator is weak and the spring is strong enough to keep the points closed. This allows for maximum voltage and current flow through the field windings which in turn produces maximum magnetism and therefore voltage, and subsequent current flow from the armature to the brushes.

(Illus. 21)



Magnetism in the voltage relay is created by voltage passing through many windings of a very thin wire wrapped around the core. One end of the wire picks up voltage from the 'A' terminal and the other is grounded. It becomes an electrically complete circuit. The core is magnetized as long as there is voltage coming from the generator. The strength of the magnet will increase whenever more voltage is sent through the windings.

When the points are closed, the field winding circuit is complete and voltage build-up in the generator fields rises unrestricted. This voltage increase also flows through the thin wire windings, creating a greater magnetism. At approximately 13 volts the cut-out relay circuit cuts into operation and current flows through the heavy copper windings. This creates an additional magnetic field that assists the primary magnet. The two magnetic fields, at a predetermined voltage output level, exert enough force to pull the points apart. Immediately several things happen.

1) Voltage no longer flows through an unrestricted path (the points) to the generator field coils. It must now take a 'bypass' route through a resistor, which severely limits the amount of voltage that is able to pass to the field coils.
2) The cut-out relay cuts out of operations, stopping the magnetism generated by the heavy windings.
3) The points spring back together because the magnet has lost its holding power.
4) When the points come together, the generator field begins to build again. The whole process begins once more and continues as long as the generator is operating. It is in this manner that voltage output is controlled.

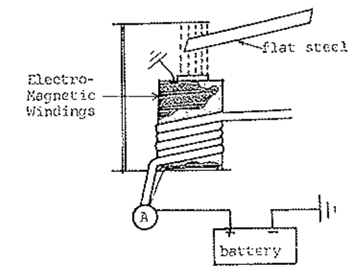
2. Maintenance: Before any maintenance is done to the regulator, it should be established that the generator is functioning correctly. This can be done by checking the procedures under "Generators; D.C. Generators". The regulator will be sufficiently isolated as to the probable cause by checking the generator output first.

3. Troubleshooting: In a "no-charge" or improper output situation always check the generator first. As there is more physical wear in this unit, failures will generally occur there first. Should the generator check out okay, follow the steps below.

   a. Visual check of regulator
      1) Loose wires at terminals
      2) Broken wires
      3) Regulator poorly grounded
      4) Soldering broken or screws loose
      5) Points dirty, burnt

   b. Insulation of electro-magnetic windings (See Illus 22). Connect a battery (proper voltage), positive (+) to terminal "A", and negative (-) to ground. Slip a piece of flat steel into the electro-magnetic field. If it pulls the metal, the coil wire is not broken.

(Illus. 22)



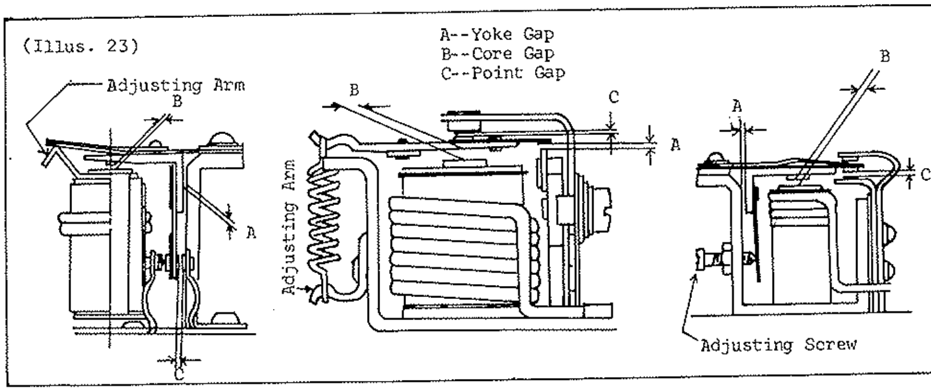
orate two shunt resistors in the regulator relay contact point circuit. These resistors are used to vary voltage and current flow through the fields circuit. To check for failure:

1) Disconnect all wires from voltage regulator assembly.
2) Set pocket tester on ohms x 1 scale.
3) Hook red (+) test lead to regulator "A" terminal.
4) Hook black (−) test lead to "F" terminal.
5) Manually operate voltage regulator relay--each of the 3 shunt positions should show as distinctly different resistance readings.
6) If the circuit shows infinite resistance in any one of the positions either the coil windings or one of the shunts is open.

d. Regulator adjustments

1) It is necessary to check and adjust the yoke, core, and point gaps, absolutely in that order of adjustment, as an aid to a correctly operating regulator. These gaps are shown on three models in Illustration 23. Check the specification sheet for the correct feeler gauge measured gaps. It is advisable to use the factory tools when bending the adjusting arm. Some have adjusting screws.

(Illus. 23)



2) Voltage output adjustment: The voltage output can be checked and corrected if the voltage is not correct, according to specification.

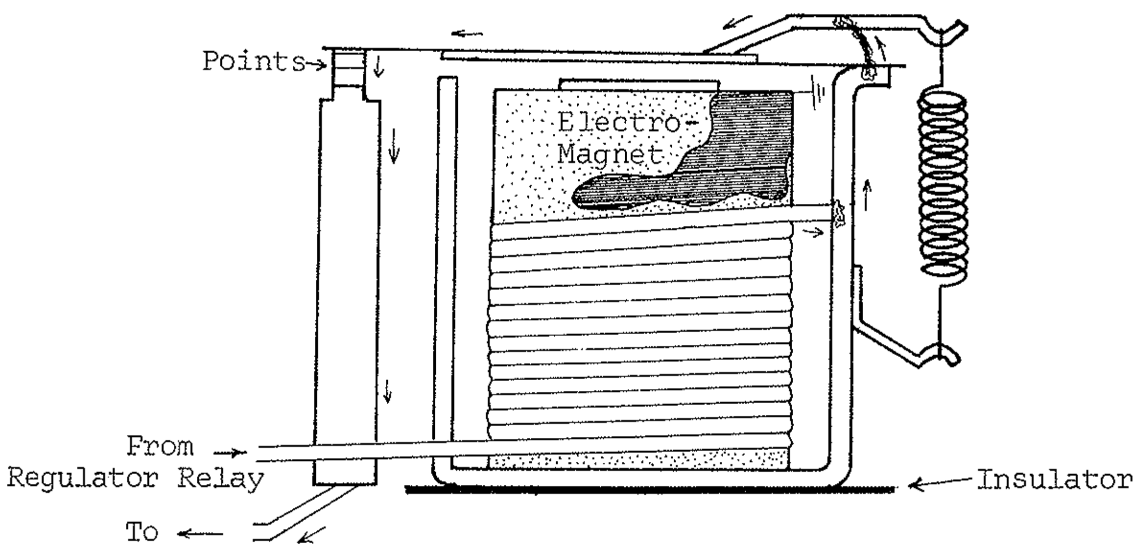
First, start the engine. Then disconnect the wire at the regulator terminal marked "B" (Battery), then hook the positive (+) lead of the volt-meter to the "B" terminal, and the negative (-) lead to ground. Next, turn the engine speed to the specified RPM and observe the voltage output. This will give the 'No Load Voltage'. If the voltage is either higher or lower than specified, use the following adjustment procedure:

The voltage can be raised or lowered by bending the spring hook (located at bottom of spring) up or down. Some models have an adjusting screw instead of a spring. The more pressure adjusted to keep the points together raises the voltage.

B. Cut-out Relay

1. Principle: The generator charges the battery at high engine RPM. However, as the RPM drops, voltage output to the battery drops off, and current from the battery flows back to the generator. This causes the battery to become discharged. To stop the back-flow, the cut-out relay is used to break the generator-battery circuit at low RPM (See Illus. 24).

This relay is basically a set of contact points kept open by a spring, and closed by an electro-magnet. When the revolutions of the generator are low, and voltage output is correspondingly low, the adjusting spring is stronger than the electromagnet. The spring separates the points, breaking the charging circuit. When the generator RPM rises high enough to supply the electro-magnet with sufficient force to overcome the spring tension, then the points come together, completing the charging circuit. The voltage supplied to the electro-magnet is pre-calculated to be higher than the battery voltage rating. In this way, the points close only when the charging voltage is strong enough to flow into, not out of, the battery.



(Illus. 24)

HOW THE ELECTROMAGNET IS ENERGIZED

1) Current flows through the heavy copper wire (directly connected to 'A' terminal) to the core anchor plate. The heavy wire is soldered to the plate.
2) One end of the thin wire winding is soldered to the core, and it picks up voltage brought to this point by the heavy copper wire.
3) This voltage flows through the thin windings to ground because the other end of the thin wire is grounded to the housing. Voltage passing through the windings creates an electromagnetic force around the core. Also, the magnetic force will increase in direct relation to an increase in generator voltage output.

1) When generator voltage is high enough to create a strong electromagnetic action, the movable point will be pulled into contact with the stationary point.
2) Voltage will now be able to flow out of the heavy copper wire, up through the core anchor plate, over and then down through the points, and finally through the 'B' terminal to the battery.
3) When the points close, and voltage flows through the heavy copper windings, a secondary magnetic field is created at the core to assist the fine wire electromagnet.
4) The primary and secondary magnetic fields ultimately work against each other, when generator voltage drops, to break the battery charging circuit. Voltage flow through the thin wire windings (voltage windings) always travels in the same direction, thereby maintaining the same magnetic polarity (N & S poles). Generator current flowing through the heavy copper winding creates an additional magnetic field with a polarity that matches that of the thin wire magnetic field. The two magnetic fields compliment each other and produce one stronger field. However, when generator output drops lower than battery voltage, then the battery voltage will start to flow back through the heavy copper windings (current carrying windings). The reversed flowing voltage will create a magnetic field with a reversed polarity. The two magnetic fields, each overlapping the other and having an opposite polarity, will cancel out both magnetic fields. During that moment, no magnetic field at all will exist. The adjusting spring is then free to pull the points apart.

2. Maintenance: When the generator and voltage relay are in good condition, the following three types of malfunctions are to be checked and adjusted: No charge, insufficient charging amperage, and uneven charging rate.

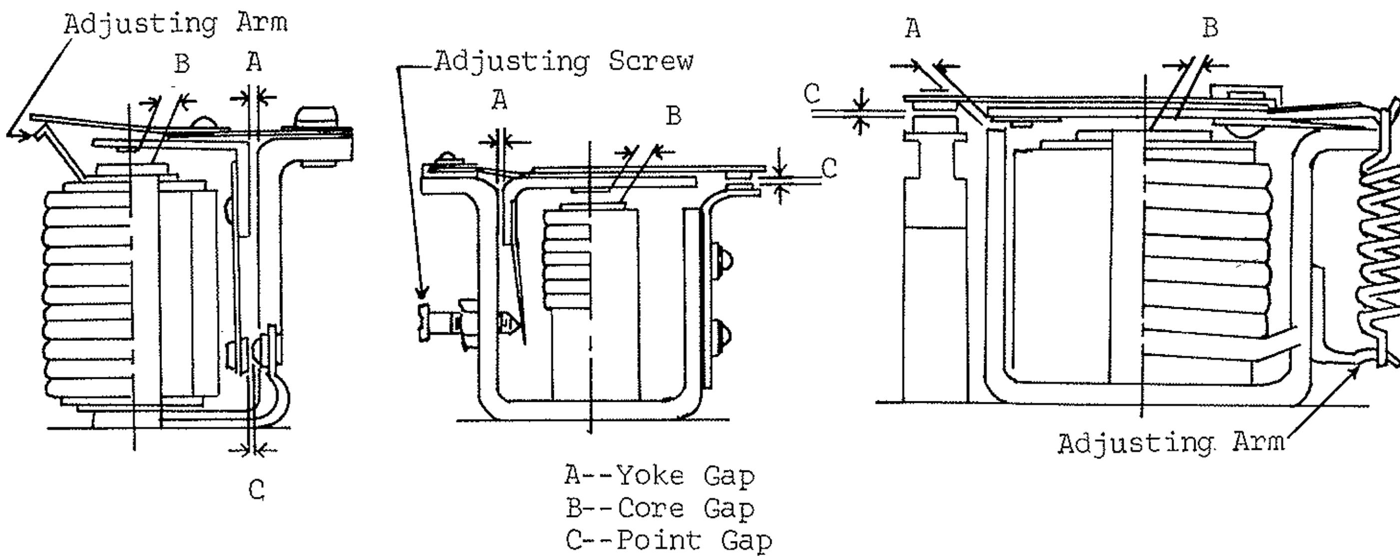
a. Make a visual check of the cut-out relay.

b. Check the cut-out relay in the same manner as in 2-b (regulator relay).

c. Adjustment of the cut-out relay (See Illus. 25).

1) The mechanical adjustments are the same as in 2-c-1 (regulator relay), and the adjustments must fullow the proper order.

(Illus. 25)



2) Cut-in voltage of the cut-out relay.

Connect a voltmeter the same as in the voltage relay checks (positive to "A" terminal, negative to ground). Start the engine and slowly raise the speed. Observe the amount of voltage being generated at the time the points close. Check with the specifications to see if the voltage is too high or too low. The correct voltage can be adjusted by bending the spring hook, the same as the voltage relay adjustment.

III. RECTIFIER

A. Principle: Some Yamaha models use an A.C. charging system. The A.C. current has to be converted into D.C. current in order to charge the battery. It is the purpose of the rectifier to change the A.C. output to D.C. current.

A.C. current is generated to the rectifier. The construction of the rectifier is designed to pass current only one way. Current flowing in only one direction is direct current. Naturally the duty of the rectifier is to stop current from flowing both ways. The test of its reliability is to check for one-way flow.

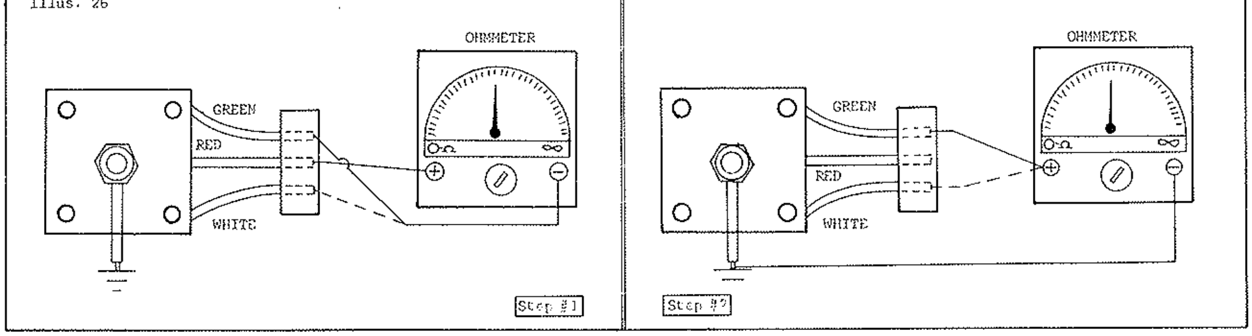
B. Continuity Check: (Silicon, Diode Rectifier (See Illus. 26)

1. Connect positive lead of ohmmeter to red lead of rectifier. Then connect negative lead of ohmmeter to the green and then the white lead of the rectifier. The ohmmeter should show a reading. Reverse the ohmmeter positive and negative leads and the meter should not get a reading.

--or--

2. Connect negative lead of ohmmeter to ground (mounting bolt). Connect the positive lead to the white and then the green wires of the rectifier. The ohmmeter should show a reading. Reverse the positive and negative leads of the ohm meter and follow the same procedure as above. The ohmmeter should show no reading (incomplete circuit).

Illus. 26



C. Continuity Check: 2-wire rectifier (selenium).

Make a continuity check for one-way flow of electricity. This can be done by hooking up one lead of an ohmmeter to the red lead, and hook the other to the white lead. Check to see if there is continuity. Now reverse the ohmmeter leads. The end result should show continuity in only one of the two lead positions. The rectifier is faulty if there is continuity in both directions, or neither direction.

IV. BATTERY

The battery in a DC charging system starts the engine and aids in powering the lights. Without periodic check-ups the battery will loose power and its life expectancy will be shortened.

A. Storage Maintenance

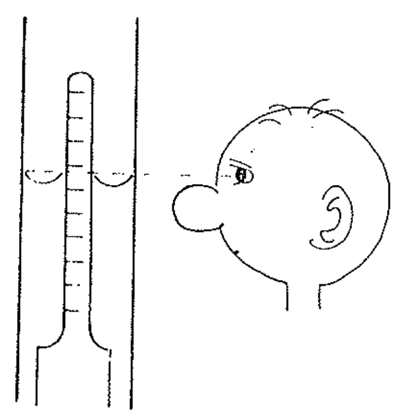
The batteries used by Yamaha are shipped dry-charged in the machine and out of stock. Do not remove the vent tube clip or cell caps until ready to fill with acid. Any air entering the cell will cause it to discharge due to the humidity (water vapor) carried in the air.

Although the battery could be used as soon as it is filled with acid, it is recommended that a trickle charge be applied to it for several hours before installation in the machine. Most of the batteries are stocked for several months, and the dry charge capacity is slowly lowered so that recharging is important. With ideal conditions of warehousing, the "instantaneous" power of the battery drops 20% one month after manufacture, and 50% after one year in stock.

B. Filling

Remove the seal on the battery and then the caps. Fill with specific gravity tested acid (1.280) to the mid-point between high and low lines. Wait 20-60 minutes after filling and check the level of acid. Re-fill as necessary to top line. Check specific gravity (Illus. 27) with a hydrometer. Specific gravity should approach specifications given in instruction sheet attached to battery.

(Illus. 27)



Acid should be clean and free of other matter. In the event of polution, sulfation will start within the battery.

C. Recharging

When filling the battery, as explained in 2, wait for an hour, or more if possible, before charging. This will allow the acid to completely permeate the spongy lead material in the cells. Failure to wait a sufficient period of time can create excessive heat within the battery during charging. This heat will cause sulfation.

The charging rate on any Yamaha battery should not exceed 10% of the Ampere Hour Rating of the battery. In other words; an 11 A.H. battery should recieve a maximum charging current rate of 1.1 amperes. This charge should continue for a period of 10 hours on a discharged battery or until specific gravity in each cell is up to the correct level and voltage of the battery, without load, is at least 0.1 v over the standard rating.

When charging, the temperature of the battery will rise. If it heats up to (or over) 110°F. stop charging and allow to cool. As the temperature increases bubbles will form on the plates. These bubbles are composed of elements of hydrogen and oxygen which is a highly explosive combination. Therefore, charge the battery in a well ventilated area.

Always clean the battery when reservicing and fill each cell with distilled water to the top line before recharging. Never add additional battery acid to a battery that has been previously serviced. Check the plastic vent tube for obstructions and proper routing. On a new battery, cut off the vent tube well above the storage crimp.

D. Installation

When installing a battery double check the polarity of the connections. Yamaha color coding uses a red cable for the positive terminal of the battery and a black cable for the negative. On some machines two six-volt batteries are wired in series to form a 12v power supply. In this system a short, red jumper cable is used between the positive lead on one battery and the negative lead on the other.

E. Operational Maintenance

Make frequent checks (at least once a month) on the acid level. Fill with distilled water to the level.

When the lights are dim, horn does not work, or starter fails; remove battery, check its charge, and recharge if necessary.

When battery is not in use for a long period, recharge once a month. A battery discharges itself whether in use or not. The higher the temperature, the faster it discharges. Always store a battery in cool, dark place.

In cold climate, the battery's chemical reaction is lowered and this will lessen the capacity, so upkeep must be maintained. Also, when a battery is discharged, the acid specific gravity is low and this will make it easier to freeze. When recharging, to get the best result, use a higher temperature room.

F. Batteries in an Electric Starter System

It requires a strong force to turn over an engine. When using a self starter, amperage requirements are high. This is usually about a 100 A electric current that drops to 50 to 40 A, that continues until the engine fires. The self starter type battery is made to furnish this current. When the battery is worn down and the electric current is not sufficient, the engine will not turn over. A fully charged battery is able to start the engine approximately 100 times before recharging.

When the engine is in good operating condition, it only takes a moment to start. If pressing the starter button for 3 to 5 seconds does not start the engine, then wait for 3 to 5 seconds to restore the battery, and try again. Pressing the starter button for long periods will run down the battery and its life will be shortened.

When the specific gravity is 1.200 at 68°F, the battery will not turn over the engine and must be recharged.

A battery should be recharged any time the hydrometer reading is 1.250 or less.

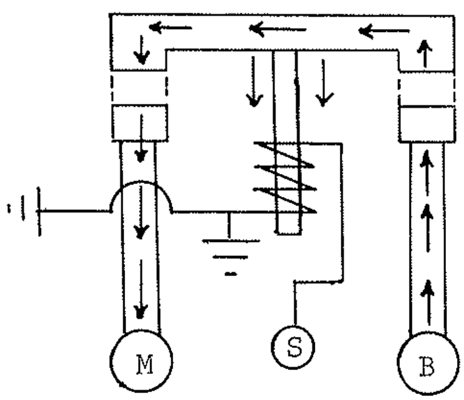
A. Principle: A starter motor needs high amperage to turn the engine. When the solenoid switch is closed 100 + amperes will surge through the solenoid contacts and then through the motor windings in the generator dynamo. After the circuit receives this current flow, it heats up and the current flow falls to 40-50 amperes. Since it is impractical to send this high amperage current through a handle bar switch a relay (starter solenoid) is used.

When the starter button on the handlebar is pressed ("S" in Illus. 28) current flows through the coil windings of the Starter Relay Switch. These windings make the core magnetic. The magnet draws the heavy duty contact points together and current flows from the battery through the solenoid contacts to the motor windings, brushes and ground. Due to the high current flow in this circuit, the starter switch and windings do not incorporate a fuse in the line.

B. Starter Handle Switch: Yamaha uses two circuit designs in the starter switch. In one, battery voltage is passed through the handle switch to the starter solenoid electro-magnet windings and then to ground. (See Illus. 28).

In the second, battery voltage passes through the solenoid electro-magnet and then to the handle switch, which provides the ground at the handle bar. In either case, the core of the relay will not become magnetic until current actually flows through the core windings.

(Illus. 28)



C. Maintenance: If the starter does not work, consider the circuit as four separate components. The battery, handlebar switch, starter solenoid and motor windings and brushes in the dynamo assembly. Check each of them in that order. For example:

Check the fuse and battery for proper charge
Check the handle switch for voltage and proper operation
Check the starter solenoid for continuity in the core windings
Check the solenoid contact points for cleanliness and continuity between the battery and motor windings when closed.
Check the motor windings, brushes, etc., as explained in B. 2-b. in the DC generator section.

D. Location: It should be noted that the location of the starter switch varies according to the different models. The starter switch is either located on the frame, as a separate unit, or it can be found in the regulator unit. This would explain the third magnetic coil in the regulator

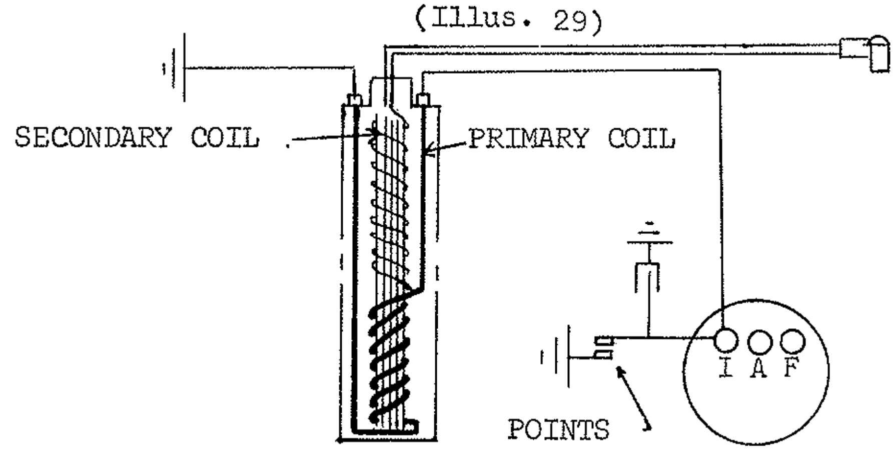
I. IGNITION COIL

A. Principle: The 6 or 12 volts put out by the battery or generator is not nearly capable of jumping the spark plug gap. It takes many thousands of volts to overcome the resistance of the air gap. Some device was needed to boost the voltage of the ignition system to properly fire the engine. The ignition coil is a type of transfer operating as a voltage booster--that is its only function.

A typical coil (See Illus. 29) is made up of the primary windings, consisting of a few hundred turns of relatively heavy wire, and a secondary winding that consists of several thousand turns of very fine wire. The secondary windings are wrapped around a soft iron core, and the primary windings are wrapped over the secondary windings. The entire assembly is slipped into a case. The cap of the case contains the primary and high tension terminals.

The points act as a circuit switch between the battery or generator and the coil. When the points close, it completes the ignition circuit and voltage flows thru the primary windings. Because the primary windings are wrapped around an iron core, a magnetic field is built up. The longer the voltage is allowed to flow into the windings, the stronger the magnetic field. By the process of self-induction, the primary voltage jumps to 150 - 300 volts. The points open, suddenly collapsing the magnetic field. As the magnetic field of the primary windings collapses, it cuts across the several thousands of turns of the secondary winding. This induces a very high voltage in the secondary windings. Because the turns of wire in the primary and secondary windings are 75:1 in ratio, the 150-200 volts of induced primary voltage is raised to 12,000 - 14,000 volts in the secondary windings. The high secondary voltage travels through the high tension lead to the spark plug.

(Illus. 29)



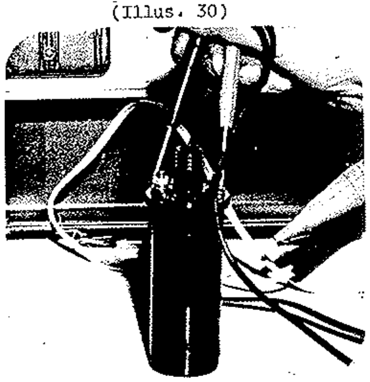
spark, weak spark and uneven firing, if the battery, contact breaker(s) and condenser(s) check out okay, follow the test procedure below:

1. Ignition Coil Resistance: With an ohmmeter set at ohms X 100 or ohms x 1,000, check for continuity between the positive and negative primary terminals. Resistance = zero ohms (Illus. 30).

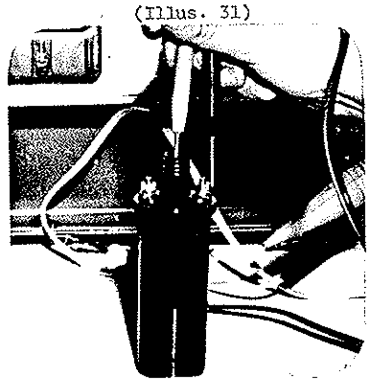
   Next check for continuity between one primary terminal and the high tension (center) secondary terminal. Resistance = 6,000 ohms (Average, check specification sheet) (See Illus. 31)

   With an ohmmeter set at ohms x 1,000 or one million check for insulation between the primary winding and the case of the coil. NOTE: The paint on the case is an insulator. Scrape some away and get a good metal-to-metal contact here. Resistance = Infinity.

(Illus. 30)



(Illus. 31)



2. Spark Test: If the engine runs, spark gap can be checked by hooking the spark gap meter on the electro-tester in series with the high tension lead from the coil to the spark plug. If not, open the ignition points, hook the negative lead from the spark gap power supply to the high side of the points. Then, hook the positive lead to any brown (charging) wire on the machine. Lastly, hook the spark gap dial leads in series with the high tension secondary leads and conduct a normal spark gap test. (In this fashion it is not necessary to remove the ignition coil from the machine for test purposes.

   NOTE: If no spark gap tester is available, remove the high tension wire from the spark plug. Next, remove the plug cap from the high tension wire. Place the bare wire approximately ¼" (6mm) from the head and kick the machine over. If a strong spark is evident the coil is useable. This test, however, will not advise you as to the coil's potential under actual running conditions, where it could break down.

3. The ignition coil produces extremely high voltage. Therefore, the high tension lead and terminals should be clean at all times. Be sure the lead is well connected to the high tension terminal and no holes or fraying are evident in the lead. If any of the above is not correct, leakage will occur and damage the coil. Water will also cause a short circuit and conductors should be well covered.

4. Precautionary Note: On the Yamaha models with magneto electrical systems, there is what is known as a balanced input-output electrical capacity. What this means is that the switch controlling the lights also controls the amount of output from the generating system.

This balance is actually quite delicate and exact. This means that if a bulb burned out and there is less consumption of the electricity produced, then the excessive charge will tend to burn out the other bulbs.

We are calling your attention here to the fact that if the tail light burns out and the machine is operated on the night position of the switch, then this will tend to throw too much current into the headlight unit and burn out that bulb also.

A bulb that breaks down because of vibration will naturally cause the same problem, so watch the tail light bulbs and replace them immediately if they become inoperative.

Special attention should be paid to the DT1(B) tachometer and speedometer lights, because the units are rubber-mounted. These lights are 'grounded' through the drive cables, which is many times unsatisfactory in that it is not a substantial ground. A short ground wire run from the unit to the mounting bracket would remove the possibility of a poor ground. Naturally this information would apply to any of our magneto models where the tachometer and speedometer are rubber mounted.

II. POINTS AND CONDENSER

The ignition coil provides the spark to the spark plug, if the coil's primary winding magnetic field is abruptly and completely collapsed. The points and condenser operate as a unit to effectively stop the ignition coil primary voltage.

A. Points

1. Principle: The ignition points act as a switch to open and close the circuit to the ignition coil's primary winding. The points are opened and closed by the rotation of the point cam.

2. Maintenance: The service life of points is reasonably long, with a minimum of maintenance. The need for maintenance can be determined by the appearance of the points. A grey color is normal. After several thousand miles, the points surfaces will become pitted from metal transference. If the contact surfaces are not too pitted, they can be cleaned up with a few strokes of a point file. It is best not to use emery cloth or sandpaper as particles can cling to the point surface and cause arcing and burning of the points. If the points are drastically pitted, replace them. An example of poorly operating points is the bike running erratic and missing.

   If the points won't last several thousand miles, it is best to try to trace the cause of the premature failure. Points will burn if they are adjusted too close, oil deposits are on the points, or the condenser is faulty. The most prevalent cause of point failure is foreign material on the contact surfaces. This can commonly be either dirt (cover or sealing grommets left off the electrical cavity) or oil (storage, improper installation, or faulty crankshaft seal).

B. Condenser

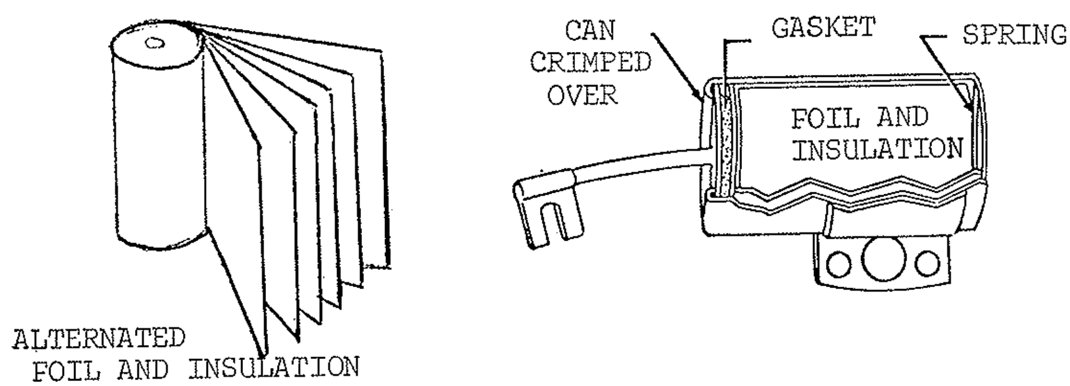
1. Principle: There is a continuous flow of electricity when the points are closed. As the points begin to open to collapse the ignition coil's magnetic field, there is a tendency for the voltage to continue to flow. Voltage will jump the gap of the points until the points are far enough apart to provide a great enough resistance. The voltage has to be kept from jumping as the points open in order to keep the points from burning and to control voltage input to the ignition coil. The condenser serves as a mechanical sponge to absorb the unwanted voltage as the points begin to open. As the points open, the voltage will flow to the path of least resistance. The condenser is hooked up before the points so that it can offer an easier path for the voltage than the separating points.

B. <u>Condenser</u>

1. (continued)

The condenser is made of several foil sheets with high quality insulation between them (See Illus. 32). These pieces of foil act as the storage spot for the voltage.

(Illus. 32)



2. <u>Maintenance</u>: There is a minimum of maintenance since it is a sealed unit.

   a. Make sure all connections are tight and clean, especially the condenser hold down screw, as it is the grounding screw.

   b. Use the electro-tester to test for capacity and insulation. See <u>Electrical Troubleshooting</u>; Electro-Tester, for test procedure.

LIGHTING AND ACCESSORIES

I. LIGHTS

There are certain steps that can be taken as preventive maintenance to help insure the proper functioning of the lighting systems. The lights consist of wiring and bulbs. The maintenance is concerned with those components.

A. Maintenance Checks:

1. Shorts in the wires.

   a. Insulation worn away leaving the bare wire.

   b. Wires sharply twisted around metal.

   c. Wires broken.

2. Poor connection (high resistance)

   a. Corroded terminals

   b. Loose nuts, bolts, screws, or connectors.

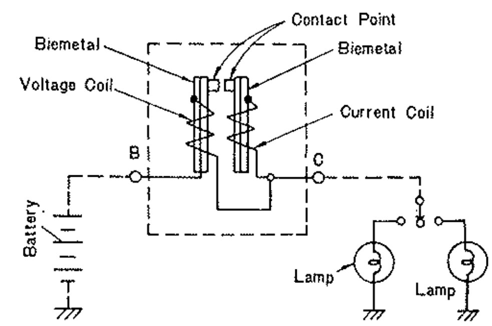
3. A.C. Lighting

   Because of the "balanced input-output" design of the A.C. systems, it is necessary to have all lights in working condition. The A.C. system is designed to put out a fixed voltage rate to supply the total electrical demands. If a bulb is burnt out, that unused current is still being put into the electrical system. This creates an overload on the other lights, causing the other bulb to burn out. Make sure that all connections are secure and clean, and replace bulbs immediately after they burn out.

II. TURN SIGNALS

Turn signals are actually a two part circuit. One part is the actual turn signal light, and the other part is the turn signal relay switch (See Illus. 33).

The relay switch is of the bi-metal type.



(Illus. 33)

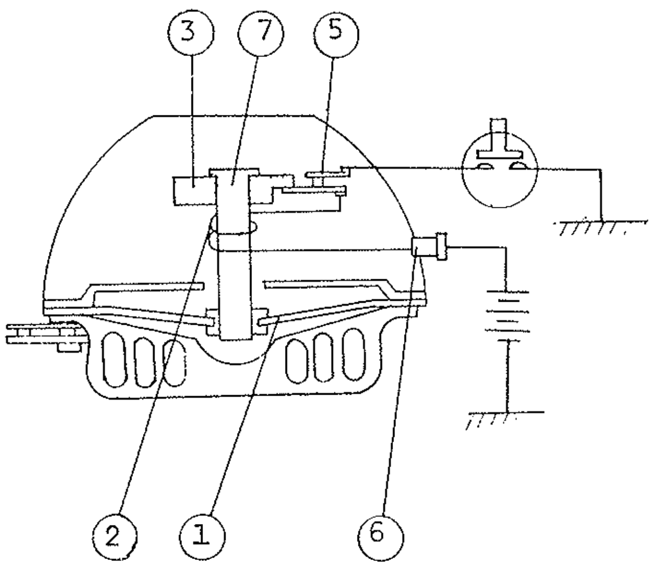
The working time of the relay switch is adjusted to the type of bulb used in the turn signal unit, so always maintain the specified bulb. If the problem arises of the turn signal not working, or taking a long time to come on, the relay switch is to be suspected. Check the bulbs and wires to assure their good condition. If everything is in operating condition, the relay is bad. Replace it.

III. HORN

A. Principle: Yamaha motorcycles are equipped with one of two types of horns.

1. Horn with intensifying trumpet: (See Illus. 34)

When the horn button is pressed, current is supplied through the terminal, coil, contact assembly and yoke. As it passes through the coil, the core becomes magnetized and pulls the armature down. Since the bottom points of the contact assembly is attached to the armature, the points will separate as the armature-shaft assembly is magnetically drawn down. Of course, the moment the points separate, the magnetic field collapses. The armature shaft assembly is lifted back up by the spring tension of the vibrator. As the armature shaft assembly slides back up, the points are again brought into contact and the magnetic coil circuit is completed again. This process is repeated very rapidly. Air vibration from the vibrator is amplified as it funnels through the expansion chamber.



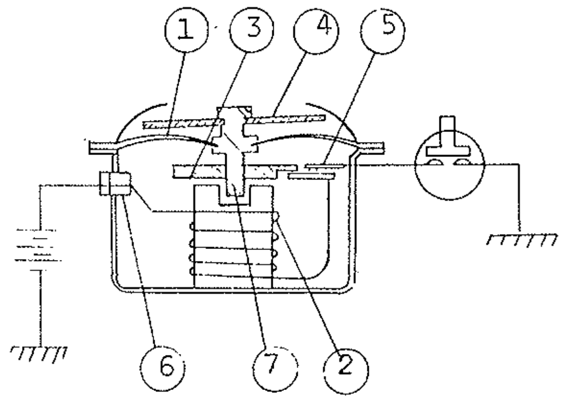
1. Vibrator
2. Coil
3. Armature
4. Resonator
5. Contact Assembly
6. Terminal
7. Shaft

(Illus. 34)

2. <u>Mike type horn</u>: (See Illus. 35)

To vibrate the vibrator, the above system is used. The difference is that when the armature is pulled down, it strikes the end of the core and activates the resonator making a loud sound.

(Illus. 35)



1. Vibrator
2. Coil
3. Armature
4. Resonator
5. Contact Assembly
6. Terminal
7. Shaft

B. <u>Maintenance</u>:

The following three malfunctions are to be checked and adjusted if necessary: does not work, a weak sound, or not uniform.

1. <u>Check by appearance</u>.

a. Dirt in the horn.

b. Water in the horn.

c. Screw is loose or soldering is broken.

d. Points are loose or worn out.

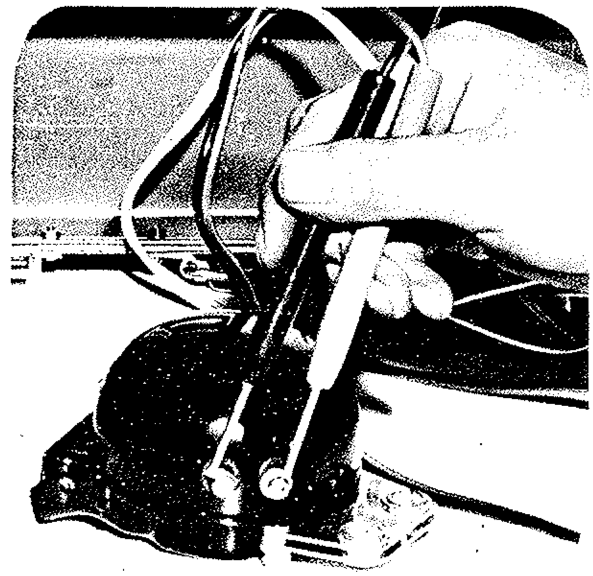
e. Armature-to-core gap is too narrow.

f. The vibrator is broken.

Check the battery and horn button for good operating condition before checking the above.

2. Check the continuity by use of the electro tester. Connect the lead wire to both horn terminals. When there is no continuity, the coil lead wire is broken, or the points are faulty and do not make contact (See Illus. 36).

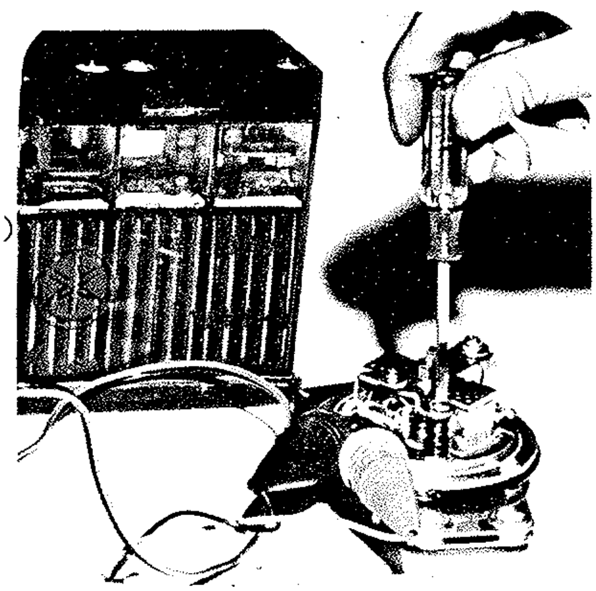
(Illus. 36)



3. Adjusting the horn:

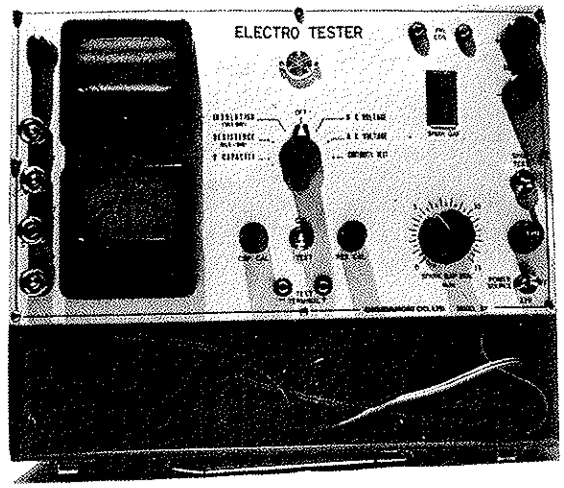
Connect the lead wire from the horn directly to the battery and tighten or loosen the adjusting screw on the horn (See Illus. 37). Normally, when tightening (screw in), the sound becomes louder. When there is no sound, unscrew the adjusting screw until sound is heard, then adjust to tone desired.

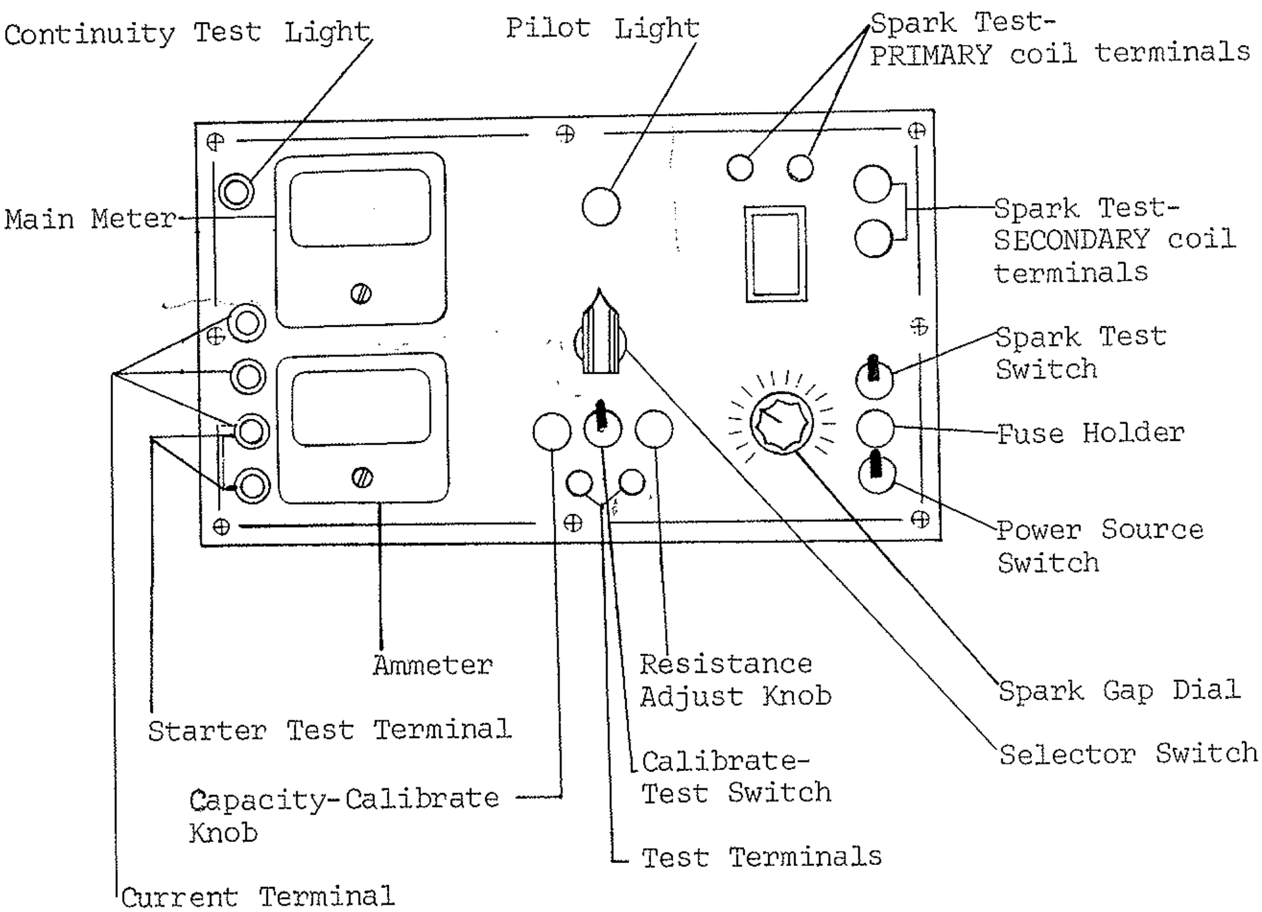
(Illus. 37)



I. ELECTRO-TESTER

When servicing or adjusting any part of the electrical system, refer to the Electrical Specifications section for all specifications or detailed information.





A. Main Tests That Are Possible With the Electro tester

D.C. voltage measurements:	from 0 to 20 volts
A.C. voltage measurements:	from 0 to 20 volts
D.C. current measurements:	from 0 to 5 amps from 0 to 20 amps from 0 to 100 amps (starter motor test only)
Insulation test:	from 0 to 20 megohms
Resistance measurements:	from 0 to 20 kilo-ohms
Condenser capacity measurements:	from 0 to 0.5 microfarads
Ignition coil test:	by adjustable spark gap with third ionizing point.
Continuity test:	by continuity light.
Ignition timing and timing advance:	by timing light.

B. Power Source Hook Up

1. Tests which require a power source:
   a. Insulation test (megohm)
   b. Resistance test (Kilo-ohm)
   c. Capacity test of condenser
   d. Continuity test
   e. Spark test (Ignition coil test)
   f. Timing light

2. Power source voltage: the power source is a 6 or 12 volt battery. The battery in the machine being serviced may be used. Before hooking up the power source, check the battery voltage to be sure the battery has sufficient voltage.

3. Check the position of power source switch: MAKE SURE it is switched to the 6 volt or to the 12 volt position, according to the battery used.

   CAUTION: The unit may be damaged by improper (excessive) voltage.

   When the power source is hooked up, the pilot lamp on the board will light up. If the pilot lamp is not lit, check the lead connection and fuse (5 amps) on the power source.

C. Measurement of Insulation and Resistance

1. Hook up the power source. Switch to proper voltage.

2. Turn the selector switch to "Insulation (megohm)" or to "Resistance (kilo-ohm)."

3. Connect the test leads to the terminals marked "Test Terminal" and clip the free ends together.

4. Zero adjustment: Adjust the "Res. Cal" knob until the pointer of the meter comes to "O" (at the right end of the scale).

5. Unclip the free ends from one another and hook them to the test piece. Watch the main scale for the resistance or insulation reading.

6. A 20 megohm scale is available for measurement of insulation. The Resistance test (kilo-ohm) is used for measurement of internal resistance of the ignition secondary coil.

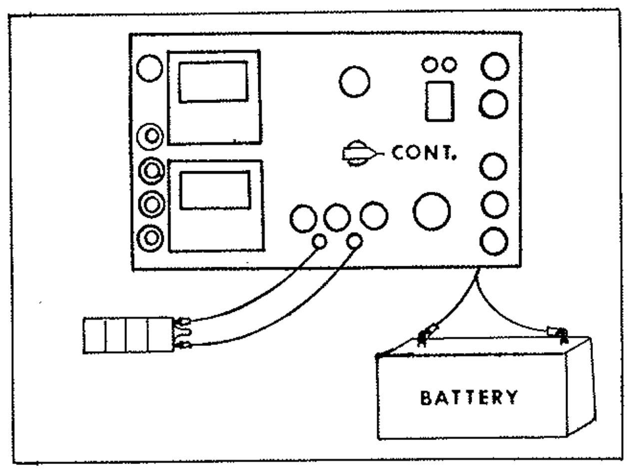
D. Continuity Test

1. Hook up the primary source leads.

2. Turn the selector switch to "CONTINUITY TEST".

3. Attach the test leads to whatever switch, wire, or circuit you are testing.

4. If the continuity lamp lights up, then an unbroken path exists for electricity to flow through--you have continuity between two points.

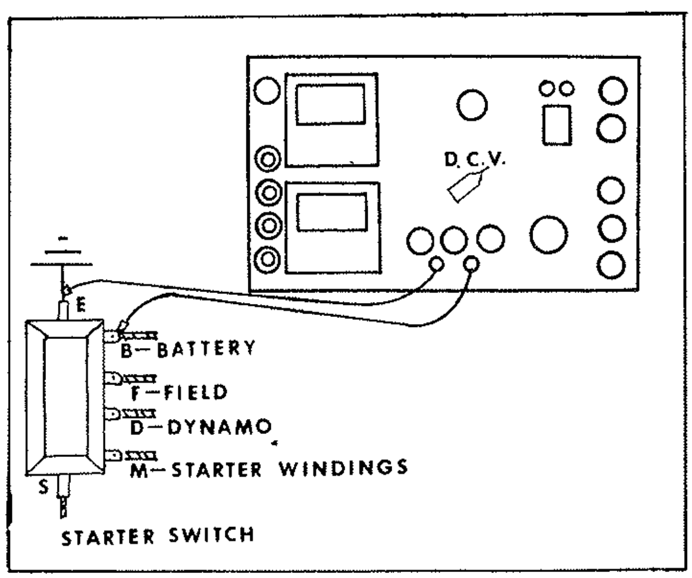


E. Measurement of Voltage Regulator Output

1. Hook up the terminal leads to the regulator, positive to the battery (B) terminal, negative to any suitable ground (E) on the motorcycle.

2. Twist the switch selector to "D.C. Voltage".

3. Start the engine, run it up to the RPM recommended in the electrical specifications sheet, and take a voltage reading off the D.C. voltage scale.



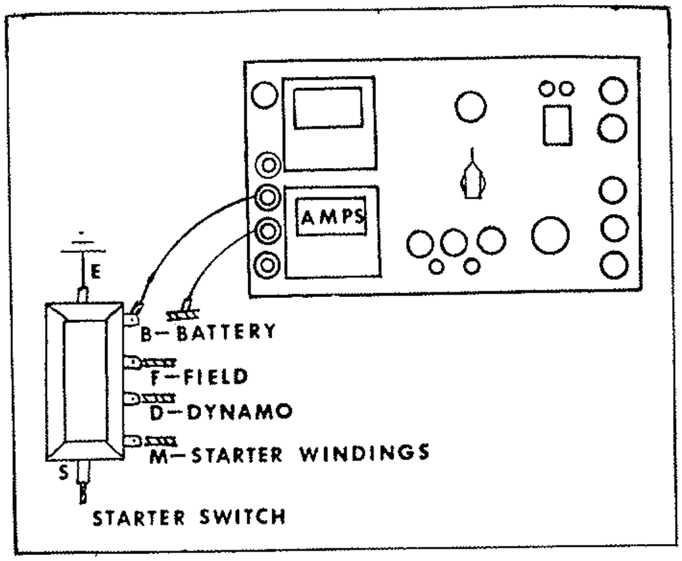
F. Measurement of Current (0-20 A)

1. At the regulator disconnect the wire that leads to the battery.

2. Hook up the amperage leads as shown in the illustration.

3. With the engine dead and the switches off, check the ammeter for a reading. There should be no amperage draw. If there is, it is an indication of a short in the electrical circuit.

3. Start the engine and check the ammeter again. This will provide you with the total amperage being used by the electrical circuit in operation.



G. Condenser Test

1. Insulation Test

   a. Measure insulation using the megohm scale mentioned in Paragraph 2D (Insulation Test). Connect the two leads to the pigtail and the housing of the condenser to be tested. The pointer of the meter will move to the right and then slowly return to the left. Keep the connection until the pointer comes to a stop.

   b. Read the pointer on the megohm scale. When it shows 5 megohms or over, the insulation is satisfactory.

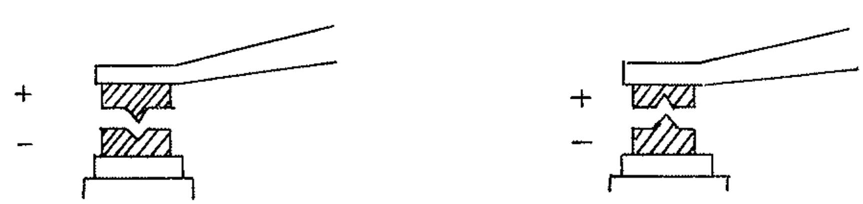
   NOTE: Immediately after this test, the tested condenser is charged with 500 volts, so discharge it by grounding the pigtail to the housing.

2. Measurement of capacity (Microfarads)

   a. Turn the selector switch to "C-Capacity".

   b. Flip the "Cal-Test" switch up.

CONDITION OF CONTACT POINTS WITH A FAULTY CONDENSER



Low Capacity

Excessive Capacity

c. Set the meter needle to point to .22 on the microfarad scale (standard rating on all Yamaha condensers).

d. Insert the test leads into the "Test-Terminals" of the tester. Clamp the free test lead ends to the condenser pigtail wire and the housing. Flip the "Cal-Test" switch down and watch the needle. The condenser is still working correctly if the needle bounces and then returns to .22 microfarads.

H. Spark Test (Ignition coil test)

1. Connect the Electro Tester to a power source.

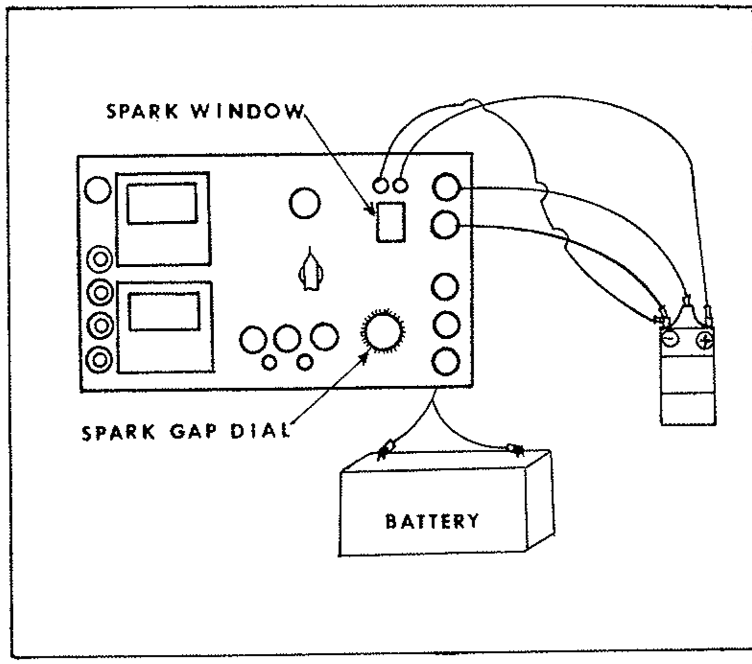
2. Hook up the leads to the ignition coil as shown in the drawing.

3. Flip the spark test switch up.

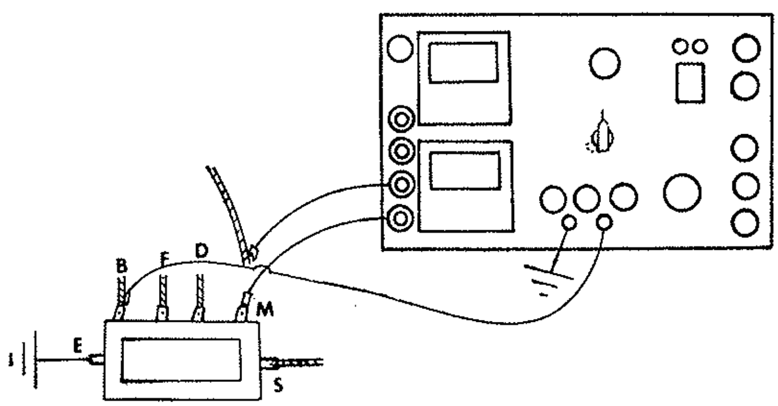
4. Twist the spark gap dial, causing the tester electrode tips to draw away from each other. Check the dial for the distance in millimeters when the spark stops jumping the distance between the electrode tips.

5. After completing this test, flip the spark test switch down.

6. An ignition coil that puts out a minimum spark length of 6mm is considered to be functioning correctly.



I. Starter Test



1. Connect a separate tachometer (electric type) to the test engine and hook up the Electro Tester as shown in the drawing to measure:

a. Start RPM
b. Current draw of the starter motor.
c. Terminal voltage of the battery

2. Set the selector switch, push the starter button, and observe:

   a. The revolutions should reach 400 RPM or more.

   b. The current draw will be 100 Amps or more for a moment and then drop down to 20-50 Amps.

   c. The voltage will drop to approximately 8 volts for a moment and then come back up to 10-10.5 volts or more.

3. Troubleshooting the starter:

   a. If the starter RPM drops lower than that specified-

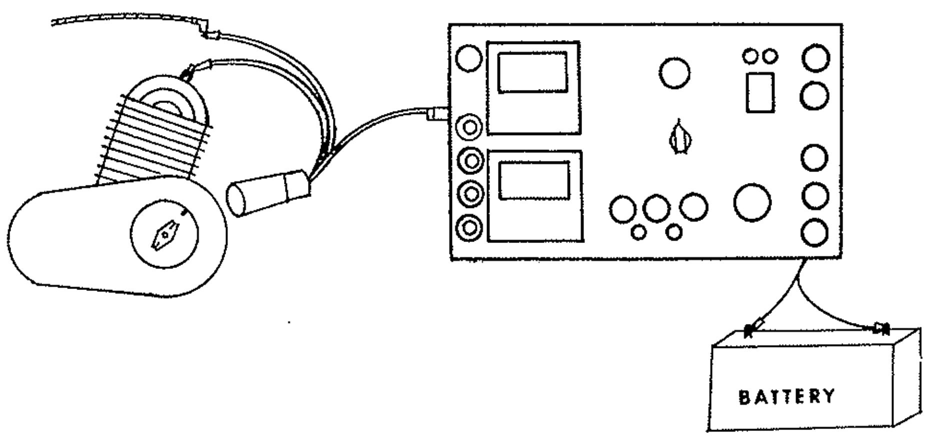
      (1) The starting current is too high. There is a short circuit.
      (2) The starter current is too low. There is a disconnection or poor contact in the circuit.
      (3) The capacity of the battery is too small.

   b. Starter RPMs are correct but the engine does not start:

      (1) Weak spark. Trouble in the ignition coil or condenser.
      (2) Strong spark. Trouble in the fuel system or the spark plug.

4. In the case of new machines, start the inspection work by checking the battery capacity. Checking electrical equipment should always begin with the power source.

J. Strobe Light (Timing light)



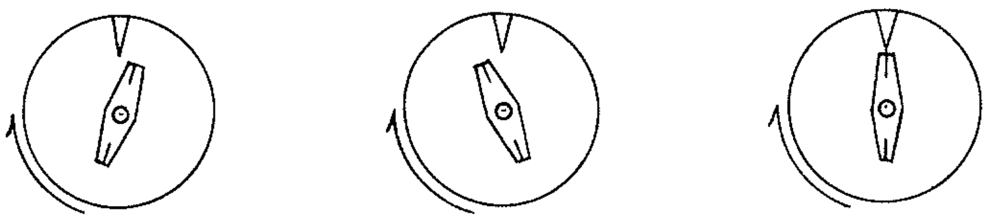
1. Determination of ignition timing variations.

   NOTE: All Yamaha machines must be timed with a dial indicator and point checker. The purpose of the strobe light is to check for abnormal operation during dynamic (running) conditions.

   a. Hook up the power source and the timing light as shown in the drawing.

b. With the engine running, the synchronized flashes of the timing light cause the rotating timing mark to appear to be in a stationary position. The rotating timing mark can now be visually checked to see if it lines up with the stationary timing mark.

c. Ignition timing is late (retarded) when the rotating mark is past the stationary mark, considering that the mark moves in the direction of crankshaft rotation; ignition timing is early (advanced) when the rotating mark is lit up before reaching the stationary mark.



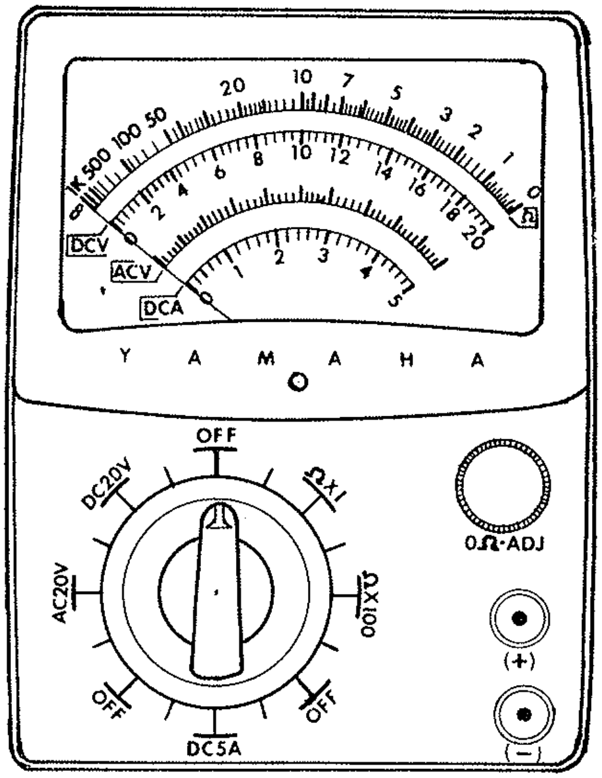
FIRING LATE (RETARDED) | FIRING EARLY (ADVANCED) | CORRECT TIMING

d. When the revolutions of an engine equipped with an automatic advance system are increased in steps, the timing mark will move in an "advanced" direction until the engine timing reaches a fully advanced position. All Yamaha timing specifications and timing marks must be at the fully advanced position.

2. Checking for identical timing between cylinders of a twin cylinder engine:

TIMING IMBALANCE BETWEEN TWO CYLINDERS | BOTH CYLINDERS TIMED RIGHT

II. POCKET TESTER



Ω X 1 —— Used for checking continuity of generator, regulator and coil, setting ignition timing and small resistance checks.

Ω X 100 —— Used for measuring insulation leakage such as generator and ignition coil, and checking other large resistance.

DC 20V —— Used to check the voltage output of generators and regulators and batteries.

AC 20 —— Used to check the voltage output of magnetos.

DC 5A —— Used to check DC current output from generators, magnetos, rectifiers, regulator, etc.

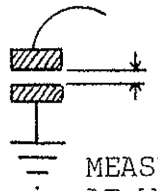
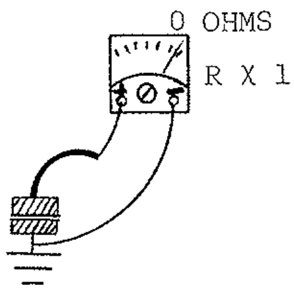
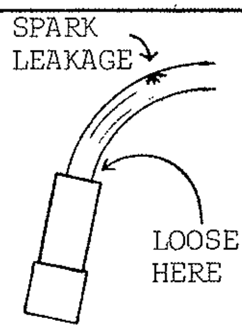
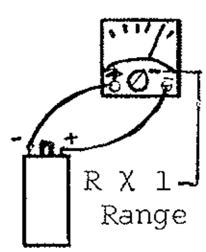
NOTE: BEFORE ANY RESISTANCE MEASUREMENTS CAN BE MADE, THE METER MUST BE ZEROED. THIS IS DONE BY SHORTING THE ENDS OF THE TWO LEADS TOGETHER AND TURNING THE OHMS ADJUST KNOB UNTIL THE NEEDLE READS ZERO.

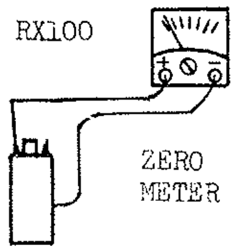
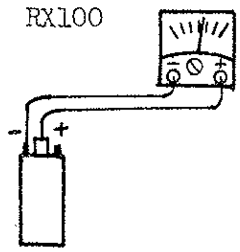
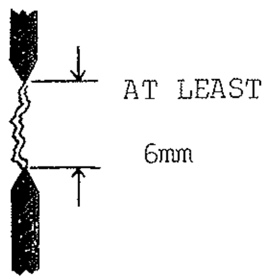
WIRING COLOR CODE FOR ALL MACHINES

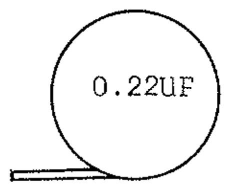
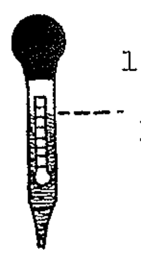
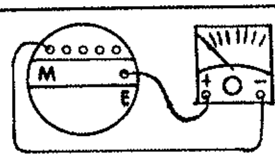
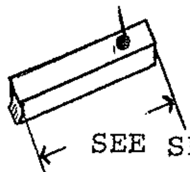
RED ---------------------------------BATTERY
LIGHT GREEN (heavy)----------------STARTER MOTOR
GREEN--------------------------------FIELDS
WHITE--------------------------------ARMATURE
BLACK--------------------------------GROUND (E)
ORANGE-------------------------------IGNITION (Gray also if twin)
BROWN--------------------------------SOURCE (Current if switch is on)
DARK BLUE----------------------------LIGHTS
GRAY---------------------------------IGNITION ON TWINS
YELLOW-------------------------------BRAKE LIGHT
BLUE AND WHITE-----------------------STARTER BUTTON
BROWN AND WHITE----------------------FLASHER RELAY
PINK---------------------------------HORN BUTTON
DARK GREEN---------------------------TURN INDICATOR
DARK BROWN---------------------------TURN INDICATOR

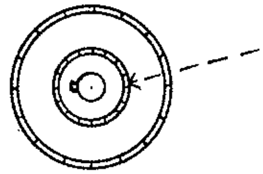
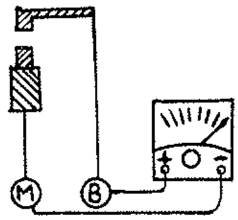
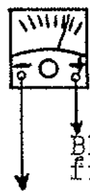
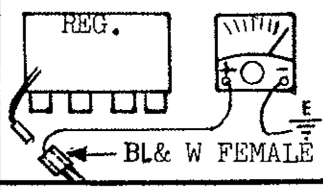
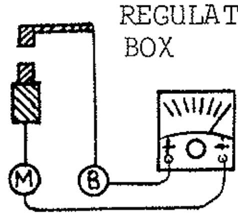
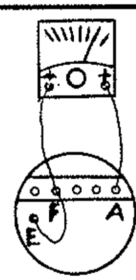
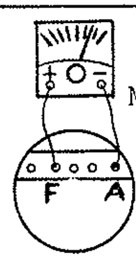
COMMON SYMBOLS FOR MOTORCYCLE ELECTRICAL COMPONENTS

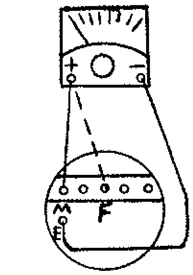
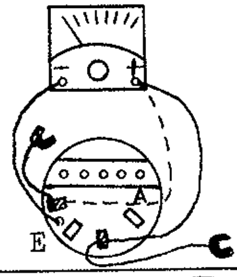
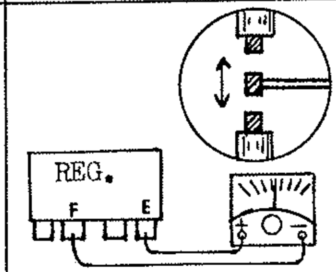
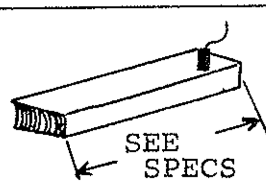
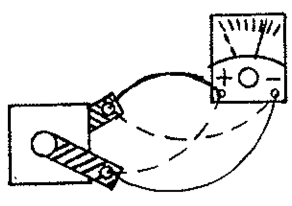
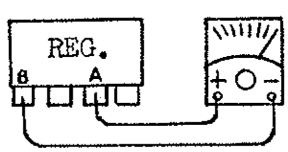
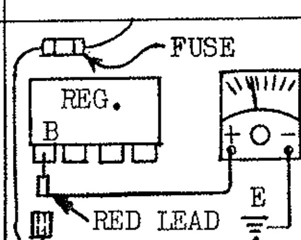
C--------COMMUTATOR B--------BATTERY A--------ARMATURE
F--------FIELD E--------GROUND (earth). M--------MOTOR (Starter)

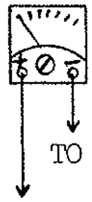
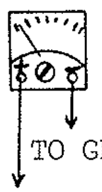
PROBLEM	CAUSE	INSPECTION METHOD	TOOL	REMARKS
	BAD PLUG	VISUAL INSPECTION	SPARKPLUG WRENCH	REPLACE
	INCORRECT POINT GAP	 MEASURED AT WIDEST OPENING	FEELER GAUGE	RESET
NO SPARK	DIRTY POINT SURFACE		POCKET TESTER ZERO METER	MUST READ ZERO OHMS WITH POINTS CLOSED CLEAN POINTS
	DAMAGED PLUG WIRE OR LOOSE PLUG CAP WIRE		VISUAL INSPECTION INSPECT BY HAND	RESEAT PLUG CAP WIRE
	NO CONTINUITY BETWEEN THE NEGATIVE ⊖ AND POSITIVE ⊕ IGNITION COIL TERMINALS		POCKET TESTER ZERO METER	SEE SERVICE SPECS FOR CORRECT READING

PROBLEM	CAUSE	INSPECTION METHOD	TOOL	REMARKS
NO SPARK	BAD PRIMARY WINDING IN IGNITION COIL		**POCKET TESTER** ZERO METER	MUST READ INFINITE REPLACE COIL
	BAD SECONDARY WINDING IN IGNITION COIL		**POCKET TESTER** ZERO METER	SEE SERVICE SPECS FOR CORRECT MAGNETO OR GENERATOR READING REPLACE COIL
	INSUFFICIENT COIL OUTPUT		ELECTROTESTER	REPLACE COIL IF SPARK GAP IS LESS THAN 6mm
MISFIRE AT HIGH R. P. M.	SPARK PLUG TOO HOT		VISUAL INSPECTION	ELECTRODE WHITE, GRAY OR BLISTERED REPLACE WITH COLDER PLUG
	SPARK PLUG TOO COLD		VISUAL INSPECTION	ELECTRODE DARK BROWN, BLACK OR OIL FOULED REPLACE WITH HOTTER PLUG
	SPARKPLUG DIRTY		VISUAL INSPECTION	CLEAN OR REPLACE PLUG

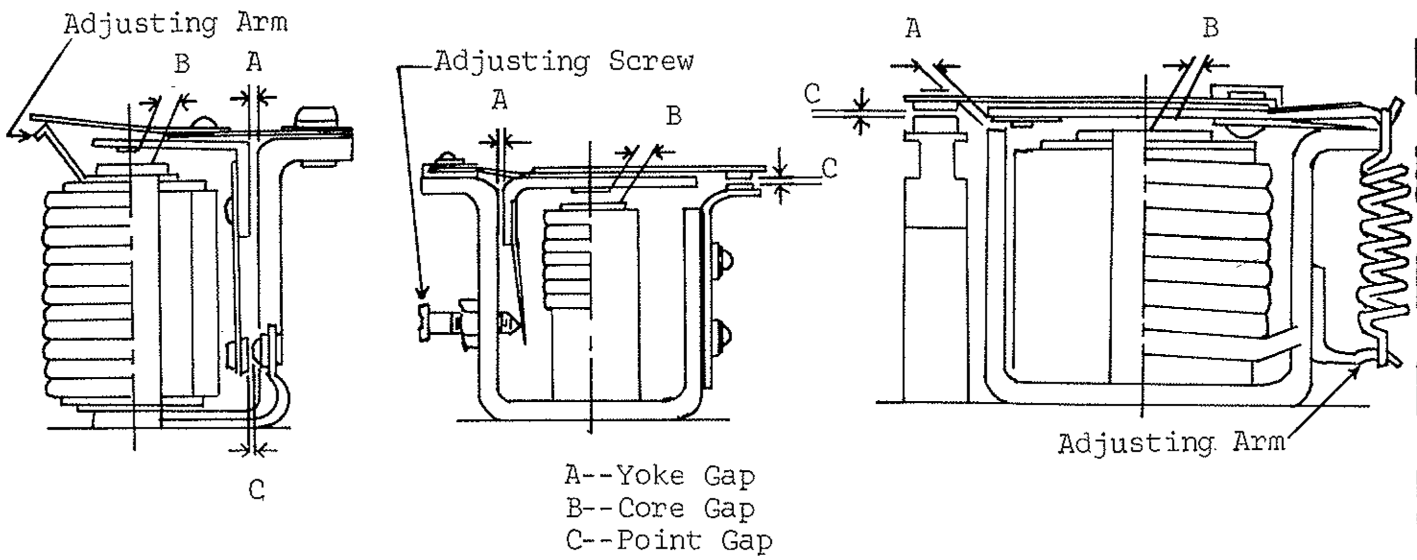
PROBLEM	CAUSE	INSPECTION METHOD	TOOL	REMARKS
MISFIRE AT HIGH R. P. M.	WEAK BREAKER POINT SPRING	INSPECT MANUALLY	FINGERS OR TENSION GAUGE	REPLACE
	INCORRECT IGNITION TIMING	INSPECT MANUALLY	DIAL INDICATOR AND POINT CHECKER	RESET
EXCESSIVE SPARK JUMP ON POINT SURFACE	ROUGH POINT SURFACE	 ROUGH	VISUAL INSPECTION	SMOOTH WITH EMERY PAPER
	DIRTY POINT SURFACE	 DIRTY	VISUAL INSPECTION	CLEAN WITH LACQUER THINNER
	WRONG CONDENSER VALUE		ELECTRO TESTER	SEE MANUAL FOR CORRECT VALUE REPLACE
STARTER MOTOR DOES NOT WORK	BATTERY DISCHARGED	 1.25 or less	HYDROMETER	RECHARGE BATTERY to 1.26 - 1.28
	SHORTED MOTOR CIRCUIT	 R X 100 RANGE	POCKET TESTER ZERO METER	DISCONNECT 'M' WIRE FROM YOKE SHOULD READ INFINITE WITH BRUSHES OFF
	WORN BRUSHES	 SEE SPECS	CALIPERS	SEE SERVICE SPECS FOR CORRECT LENGTH AND TOLERANCE

PROBLEM	CAUSE	INSPECTION METHOD	TOOL	REMARKS
STARTER MOTOR DOES NOT OPERATE CORRECTLY	COMMUTATOR WORN OUT		 VISUAL INSPECTION	REPLACE OR TURN DOWN
	NO CONTINUITY BETWEEN BATTERY AND MOTOR	STARTER SWITCH IN REGULATOR BOX 	POCKET TESTER R X 1 RANGE	MUST READ ZERO OHMS WITH CONTACTS CLOSED
	STARTER WINDINGS BROKEN	 BROWN WIRE from reg. BLUE & WHITE WIRE from reg.	POCKET TESTER R X 1 RANGE ZERO METER	SEE SERVICE SPECS FOR CORRECT READING
	NO CONTINUITY BETWEEN STARTER BUTTON AND GROUND	 REG. BL& W FEMALE	POCKET TESTER R X 1 RANGE POS.- TO BLUE & WHITE FEMALE NEG.- TO GROUND	CLEAN POINTS WITH LACQUER THINNER, & EMERY #400 SHOULD READ ZERO OHMS.
STARTER MOTOR WILL NOT STOP	**STUCK STARTER RELAY**	STARTER SWITCH IN REGULATOR BOX 	POCKET TESTER R X 1 RANGE	CLEAN POINTS WITH LACQUER THINNER AND EMERY #400 SHOULD READ INFINITE WITH POINTS OPEN
GENERATOR DOES NOT CHARGE	CHECK VOLTAGE OUTPUT FROM GENERATOR (DYNAMO) GROUND FIELD WITH JUMPER WIRE FROM 'F' TO 'E'		POCKET TESTER DC20V RANGE DO NOT EXCEED 2500 RPM	DISCONNECT 'F' & 'A' WIRES. SEE SERVICE SPECS FOR CORRECT RPM AND READING
	BROKEN FIELD COIL	 ZERO METER	POCKET TESTER R X 1 RANGE REMOVE ARMATURE AND FIELD WIRES LIFT OFF BRUSHES	SEE SERVICE SPECS FOR CORRECT READING

PROBLEM	CAUSE	INSPECTION METHOD	TOOL	REMARKS
GENERATOR DOES NOT CHARGE	GROUNDED FIELD OR MOTOR COIL		**POCKET TESTER** R X 100 RANGE NEG.- TO GROUND	SHOULD READ INFINITY DISCONNECT ALL WIRES AND LIFT OFF BRUSHES
	GROUNDED +(POS) BRUSH HOLDER		**POCKET TESTER** R X 100 RANGE	SHOULD READ INFINITY DISCONNECT BRUSH LEAD WIRES FROM ARMATURE TERM. & LIFT BRUSHES FROM ARMATURE
	BROKEN REGULATOR FIELD COIL		**POCKET TESTER** R X 1 RANGE HOLD MOVING POINT CENTERED	**SEE SERVICE SPECS FOR CORRECT READING**
	BRUSH LENGTH TOO SHORT		CALIPERS	**SEE SERVICE SPECS FOR CORRECT LENGTH & TOLERANCE**
	CHECKING RECTIFIER FOR REVERSE CURRENT FLOW		**POCKET TESTER** R X 100 RANGE CHECK READING THEN REVERSE LEADS.	**SHOULD READ LOW RESISTANCE CHANGE LEADS, SHOULD READ INFINITY**
	BROKEN CUT-OUT RELAY COIL		**POCKET TESTER** R X 1 RANGE CLOSE CUT-OUT RELAY POINT	**SEE SERVICE SPECS FOR CORRECT READING**
	CHECK VOLTAGE OUTPUT FROM REGULATOR (No Load)		**POCKET TESTER** DC 20V RANGE. DISCONNECT RED LEAD FROM REGULATOR,(+) TO RED LEAD	**SEE SERVICE SPECS FOR CORRECT RPM & READING**

PROBLEM	CAUSE	INSPECTION METHOD	TOOL	REMARKS
FUSE BLOWS WHEN IGNITION SWITCH IS TURNED ON	SHORT IN BROWN WIRE	 TO GROUND TO BROWN WIRE DISCONNECT CHARGING LIGHT TURN IGNITION <u>OFF</u> HOLD IGNITION POINTS OPEN	**<u>POCKET TESTER</u>** R X 1 RANGE	OHM METER MUST READ INFINITE RESISTANCE
FUSE BLOWS WHEN LIGHTS ARE TURNED ON	SHORT IN LIGHTING CIRCUIT	 TO GROUND TO DARK BLUE WIRE DISCONNECT YELLOW AND GREEN HEAD-LIGHT WIRES REMOVE TAILLIGHT BULB	**POCKET TESTER** R X 1 RANGE	METER MUST READ INFINITE RESISTANCE

(Illus. 25)



2) Cut-in voltage of the cut-out relay.

Connect a voltmeter the same as in the voltage relay checks (positive to "A" terminal, negative to ground). Start the engine and slowly raise the speed. Observe the amount of voltage being generated at the time the points close. Check with the specifications to see if the voltage is too high or too low. The correct voltage can be adjusted by bending the spring hook, the same as the voltage relay adjustment.

III. RECTIFIER

A. Principle: Some Yamaha models use an A.C. charging system. The A.C. current has to be converted into D.C. current in order to charge the battery. It is the purpose of the rectifier to change the A.C. output to D.C. current.

A.C. current is generated to the rectifier. The construction of the rectifier is designed to pass current only one way. Current flowing in only one direction is direct current. Naturally the duty of the rectifier is to stop current from flowing both ways. The test of its reliability is to check for one-way flow.

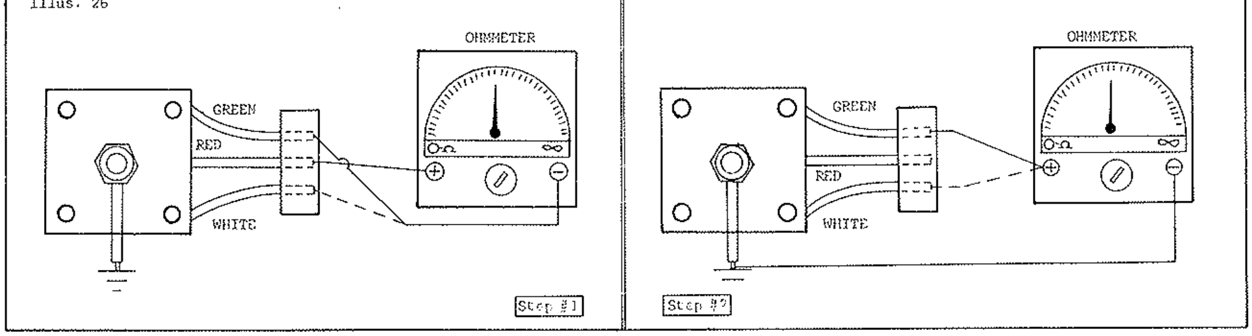
B. Continuity Check: (Silicon, Diode Rectifier (See Illus. 26)

1. Connect positive lead of ohmmeter to red lead of rectifier. Then connect negative lead of ohmmeter to the green and then the white lead of the rectifier. The ohmmeter should show a reading. Reverse the ohmmeter positive and negative leads and the meter should not get a reading.

--or--

2. Connect negative lead of ohmmeter to ground (mounting bolt). Connect the positive lead to the white and then the green wires of the rectifier. The ohmmeter should show a reading. Reverse the positive and negative leads of the ohm meter and follow the same procedure as above. The ohmmeter should show no reading (incomplete circuit).

Illus. 26



C. Continuity Check: 2-wire rectifier (selenium).

Make a continuity check for one-way flow of electricity. This can be done by hooking up one lead of an ohmmeter to the red lead, and hook the other to the white lead. Check to see if there is continuity. Now reverse the ohmmeter leads. The end result should show continuity in only one of the two lead positions. The rectifier is faulty if there is continuity in both directions, or neither direction.

IV. BATTERY

The battery in a DC charging system starts the engine and aids in powering the lights. Without periodic check-ups the battery will loose power and its life expectancy will be shortened.

A. Storage Maintenance

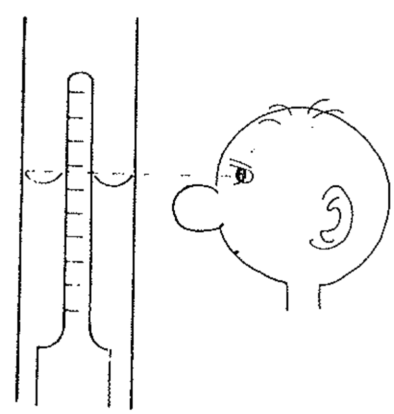
The batteries used by Yamaha are shipped dry-charged in the machine and out of stock. Do not remove the vent tube clip or cell caps until ready to fill with acid. Any air entering the cell will cause it to discharge due to the humidity (water vapor) carried in the air.

Although the battery could be used as soon as it is filled with acid, it is recommended that a trickle charge be applied to it for several hours before installation in the machine. Most of the batteries are stocked for several months, and the dry charge capacity is slowly lowered so that recharging is important. With ideal conditions of warehousing, the "instantaneous" power of the battery drops 20% one month after manufacture, and 50% after one year in stock.

B. Filling

Remove the seal on the battery and then the caps. Fill with specific gravity tested acid (1.280) to the mid-point between high and low lines. Wait 20-60 minutes after filling and check the level of acid. Re-fill as necessary to top line. Check specific gravity (Illus. 27) with a hydrometer. Specific gravity should approach specifications given in instruction sheet attached to battery.

(Illus. 27)



Acid should be clean and free of other matter. In the event of polution, sulfation will start within the battery.

C. Recharging

When filling the battery, as explained in 2, wait for an hour, or more if possible, before charging. This will allow the acid to completely permeate the spongy lead material in the cells. Failure to wait a sufficient period of time can create excessive heat within the battery during charging. This heat will cause sulfation.

The charging rate on any Yamaha battery should not exceed 10% of the Ampere Hour Rating of the battery. In other words; an 11 A.H. battery should recieve a maximum charging current rate of 1.1 amperes. This charge should continue for a period of 10 hours on a discharged battery or until specific gravity in each cell is up to the correct level and voltage of the battery, without load, is at least 0.1 v over the standard rating.

When charging, the temperature of the battery will rise. If it heats up to (or over) 110°F. stop charging and allow to cool. As the temperature increases bubbles will form on the plates. These bubbles are composed of elements of hydrogen and oxygen which is a highly explosive combination. Therefore, charge the battery in a well ventilated area.

Always clean the battery when reservicing and fill each cell with distilled water to the top line before recharging. Never add additional battery acid to a battery that has been previously serviced. Check the plastic vent tube for obstructions and proper routing. On a new battery, cut off the vent tube well above the storage crimp.

D. Installation

When installing a battery double check the polarity of the connections. Yamaha color coding uses a red cable for the positive terminal of the battery and a black cable for the negative. On some machines two six-volt batteries are wired in series to form a 12v power supply. In this system a short, red jumper cable is used between the positive lead on one battery and the negative lead on the other.

E. Operational Maintenance

Make frequent checks (at least once a month) on the acid level. Fill with distilled water to the level.

When the lights are dim, horn does not work, or starter fails; remove battery, check its charge, and recharge if necessary.

When battery is not in use for a long period, recharge once a month. A battery discharges itself whether in use or not. The higher the temperature, the faster it discharges. Always store a battery in cool, dark place.

In cold climate, the battery's chemical reaction is lowered and this will lessen the capacity, so upkeep must be maintained. Also, when a battery is discharged, the acid specific gravity is low and this will make it easier to freeze. When recharging, to get the best result, use a higher temperature room.

F. Batteries in an Electric Starter System

It requires a strong force to turn over an engine. When using a self starter, amperage requirements are high. This is usually about a 100 A electric current that drops to 50 to 40 A, that continues until the engine fires. The self starter type battery is made to furnish this current. When the battery is worn down and the electric current is not sufficient, the engine will not turn over. A fully charged battery is able to start the engine approximately 100 times before recharging.

When the engine is in good operating condition, it only takes a moment to start. If pressing the starter button for 3 to 5 seconds does not start the engine, then wait for 3 to 5 seconds to restore the battery, and try again. Pressing the starter button for long periods will run down the battery and its life will be shortened.

When the specific gravity is 1.200 at 68°F, the battery will not turn over the engine and must be recharged.

A battery should be recharged any time the hydrometer reading is 1.250 or less.

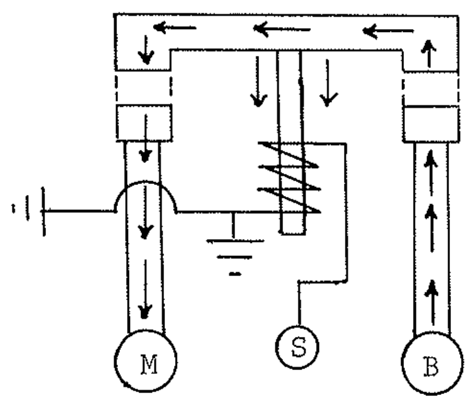
A. Principle: A starter motor needs high amperage to turn the engine. When the solenoid switch is closed 100 + amperes will surge through the solenoid contacts and then through the motor windings in the generator dynamo. After the circuit receives this current flow, it heats up and the current flow falls to 40-50 amperes. Since it is impractical to send this high amperage current through a handle bar switch a relay (starter solenoid) is used.

When the starter button on the handlebar is pressed ("S" in Illus. 28) current flows through the coil windings of the Starter Relay Switch. These windings make the core magnetic. The magnet draws the heavy duty contact points together and current flows from the battery through the solenoid contacts to the motor windings, brushes and ground. Due to the high current flow in this circuit, the starter switch and windings do not incorporate a fuse in the line.

B. Starter Handle Switch: Yamaha uses two circuit designs in the starter switch. In one, battery voltage is passed through the handle switch to the starter solenoid electro-magnet windings and then to ground. (See Illus. 28).

In the second, battery voltage passes through the solenoid electro-magnet and then to the handle switch, which provides the ground at the handle bar. In either case, the core of the relay will not become magnetic until current actually flows through the core windings.

(Illus. 28)



C. Maintenance: If the starter does not work, consider the circuit as four separate components. The battery, handlebar switch, starter solenoid and motor windings and brushes in the dynamo assembly. Check each of them in that order. For example:

Check the fuse and battery for proper charge
Check the handle switch for voltage and proper operation
Check the starter solenoid for continuity in the core windings
Check the solenoid contact points for cleanliness and continuity between the battery and motor windings when closed.
Check the motor windings, brushes, etc., as explained in B. 2-b. in the DC generator section.

D. Location: It should be noted that the location of the starter switch varies according to the different models. The starter switch is either located on the frame, as a separate unit, or it can be found in the regulator unit. This would explain the third magnetic coil in the regulator

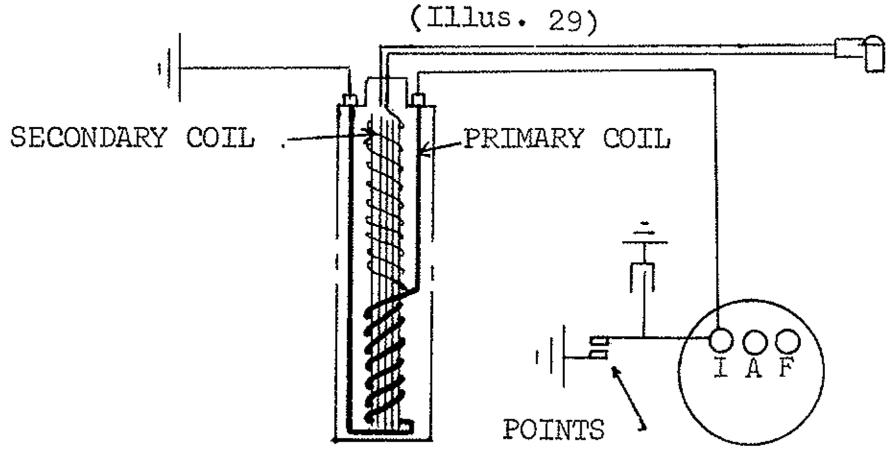
I. IGNITION COIL

A. Principle: The 6 or 12 volts put out by the battery or generator is not nearly capable of jumping the spark plug gap. It takes many thousands of volts to overcome the resistance of the air gap. Some device was needed to boost the voltage of the iqnition system to properly fire the engine. The ignition coil is a type of transfer operating as a voltage booster--that is its only function.

A typical coil (See Illus. 29) is made up of the primary windings, consisting of a few hundred turns of relatively heavy wire, and a secondary winding that consists of several thousand turns of very fine wire. The secondary windings are wrapped around a soft iron core, and the primary windings are wrapped over the secondary windings. The entire assembly is slipped into a case. The cap of the case contains the primary and high tension terminals.

The points act as a circuit switch between the battery or generator and the coil. When the points close, it completes the ignition circuit and voltage flows thru the primary windings. Because the primary windings are wrapped around an iron core, a magnetic field is built up. The longer the voltage is allowed to flow into the windings, the stronger the magnetic field. By the process of self-induction, the primary voltage jumps to 150 - 300 volts. The points open, suddenly collapsing the magnetic field. As the magnetic field of the primary windings collapses, it cuts across the several thousands of turns of the secondary winding. This induces a very high voltage in the secondary windings. Because the turns of wire in the primary and secondary windings are 75:1 in ratio, the 150-200 volts of induced primary voltage is raised to 12,000 - 14,000 volts in the secondary windings. The high secondary voltage travels through the high tension lead to the spark plug.

(Illus. 29)



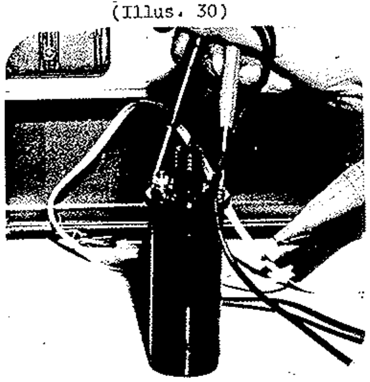
spark, weak spark and uneven firing, if the battery, contact breaker(s) and condenser(s) check out okay, follow the test procedure below:

1. Ignition Coil Resistance: With an ohmmeter set at ohms X 100 or ohms x 1,000, check for continuity between the positive and negative primary terminals. Resistance = zero ohms (Illus. 30).

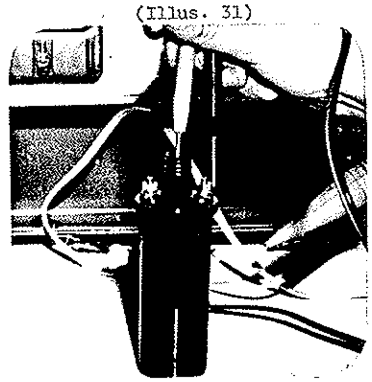
   Next check for continuity between one primary terminal and the high tension (center) secondary terminal. Resistance = 6,000 ohms (Average, check specification sheet) (See Illus. 31)

   With an ohmmeter set at ohms x 1,000 or one million check for insulation between the primary winding and the case of the coil. NOTE: The paint on the case is an insulator. Scrape some away and get a good metal-to-metal contact here. Resistance = Infinity.

(Illus. 30)



(Illus. 31)



2. Spark Test: If the engine runs, spark gap can be checked by hooking the spark gap meter on the electro-tester in series with the high tension lead from the coil to the spark plug. If not, open the ignition points, hook the negative lead from the spark gap power supply to the high side of the points. Then, hook the positive lead to any brown (charging) wire on the machine. Lastly, hook the spark gap dial leads in series with the high tension secondary leads and conduct a normal spark gap test. (In this fashion it is not necessary to remove the ignition coil from the machine for test purposes.

   NOTE: If no spark gap tester is available, remove the high tension wire from the spark plug. Next, remove the plug cap from the high tension wire. Place the bare wire approximately ¼" (6mm) from the head and kick the machine over. If a strong spark is evident the coil is useable. This test, however, will not advise you as to the coil's potential under actual running conditions, where it could break down.

3. The ignition coil produces extremely high voltage. Therefore, the high tension lead and terminals should be clean at all times. Be sure the lead is well connected to the high tension terminal and no holes or fraying are evident in the lead. If any of the above is not correct, leakage will occur and damage the coil. Water will also cause a short circuit and conductors should be well covered.

4. Precautionary Note: On the Yamaha models with magneto electrical systems, there is what is known as a balanced input-output electrical capacity. What this means is that the switch controlling the lights also controls the amount of output from the generating system.

This balance is actually quite delicate and exact. This means that if a bulb burned out and there is less consumption of the electricity produced, then the excessive charge will tend to burn out the other bulbs.

We are calling your attention here to the fact that if the tail light burns out and the machine is operated on the night position of the switch, then this will tend to throw too much current into the headlight unit and burn out that bulb also.

A bulb that breaks down because of vibration will naturally cause the same problem, so watch the tail light bulbs and replace them immediately if they become inoperative.

Special attention should be paid to the DT1(B) tachometer and speedometer lights, because the units are rubber-mounted. These lights are 'grounded' through the drive cables, which is many times unsatisfactory in that it is not a substantial ground. A short ground wire run from the unit to the mounting bracket would remove the possibility of a poor ground. Naturally this information would apply to any of our magneto models where the tachometer and speedometer are rubber mounted.

II. POINTS AND CONDENSER

The ignition coil provides the spark to the spark plug, if the coil's primary winding magnetic field is abruptly and completely collapsed. The points and condenser operate as a unit to effectively stop the ignition coil primary voltage.

A. Points

1. Principle: The ignition points act as a switch to open and close the circuit to the ignition coil's primary winding. The points are opened and closed by the rotation of the point cam.

2. Maintenance: The service life of points is reasonably long, with a minimum of maintenance. The need for maintenance can be determined by the appearance of the points. A grey color is normal. After several thousand miles, the points surfaces will become pitted from metal transference. If the contact surfaces are not too pitted, they can be cleaned up with a few strokes of a point file. It is best not to use emery cloth or sandpaper as particles can cling to the point surface and cause arcing and burning of the points. If the points are drastically pitted, replace them. An example of poorly operating points is the bike running erratic and missing.

   If the points won't last several thousand miles, it is best to try to trace the cause of the premature failure. Points will burn if they are adjusted too close, oil deposits are on the points, or the condenser is faulty. The most prevalent cause of point failure is foreign material on the contact surfaces. This can commonly be either dirt (cover or sealing grommets left off the electrical cavity) or oil (storage, improper installation, or faulty crankshaft seal).

B. Condenser

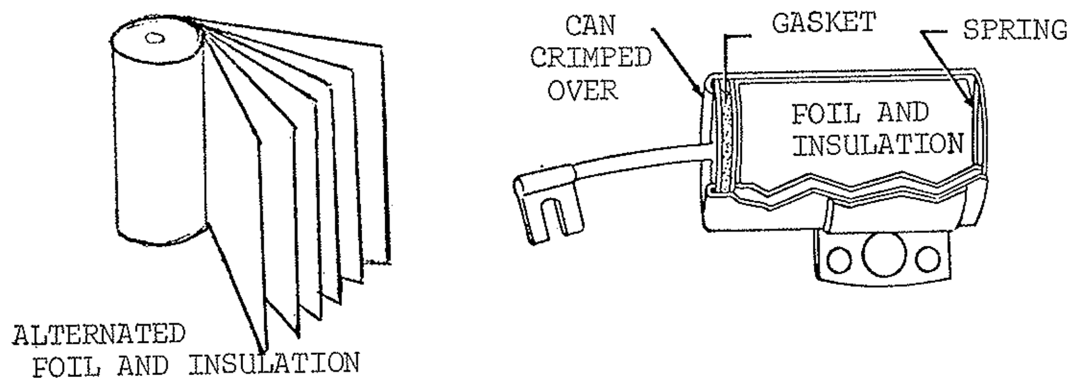
1. Principle: There is a continuous flow of electricity when the points are closed. As the points begin to open to collapse the ignition coil's magnetic field, there is a tendency for the voltage to continue to flow. Voltage will jump the gap of the points until the points are far enough apart to provide a great enough resistance. The voltage has to be kept from jumping as the points open in order to keep the points from burning and to control voltage input to the ignition coil. The condenser serves as a mechanical sponge to absorb the unwanted voltage as the points begin to open. As the points open, the voltage will flow to the path of least resistance. The condenser is hooked up before the points so that it can offer an easier path for the voltage than the separating points.

B. Condenser

1. (continued)

The condenser is made of several foil sheets with high quality insulation between them (See Illus. 32). These pieces of foil act as the storage spot for the voltage.

(Illus. 32)



2. Maintenance: There is a minimum of maintenance since it is a sealed unit.

   a. Make sure all connections are tight and clean, especially the condenser hold down screw, as it is the grounding screw.

   b. Use the electro-tester to test for capacity and insulation. See Electrical Troubleshooting; Electro-Tester, for test procedure.

LIGHTING AND ACCESSORIES

I. LIGHTS

There are certain steps that can be taken as preventive maintenance to help insure the proper functioning of the lighting systems. The lights consist of wiring and bulbs. The maintenance is concerned with those components.

A. Maintenance Checks:

1. Shorts in the wires.

   a. Insulation worn away leaving the bare wire.

   b. Wires sharply twisted around metal.

   c. Wires broken.

2. Poor connection (high resistance)

   a. Corroded terminals

   b. Loose nuts, bolts, screws, or connectors.

3. A.C. Lighting

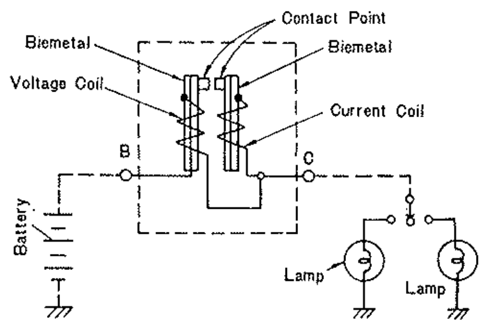
   Because of the "balanced input-output" design of the A.C. systems, it is necessary to have all lights in working condition. The A.C. system is designed to put out a fixed voltage rate to supply the total electrical demands. If a bulb is burnt out, that unused current is still being put into the electrical system. This creates an overload on the other lights, causing the other bulb to burn out. Make sure that all connections are secure and clean, and replace bulbs immediately after they burn out.

II. TURN SIGNALS

Turn signals are actually a two part circuit. One part is the actual turn signal light, and the other part is the turn signal relay switch (See Illus. 33).

The relay switch is of the bi-metal type.

(Illus. 33)



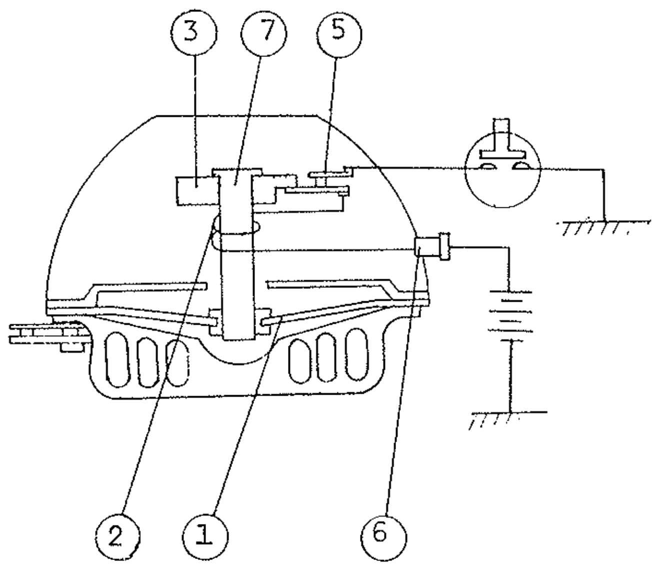
The working time of the relay switch is adjusted to the type of bulb used in the turn signal unit, so always maintain the specified bulb. If the problem arises of the turn signal not working, or taking a long time to come on, the relay switch is to be suspected. Check the bulbs and wires to assure their good condition. If everything is in operating condition, the relay is bad. Replace it.

III. HORN

A. Principle: Yamaha motorcycles are equipped with one of two types of horns.

1. Horn with intensifying trumpet: (See Illus. 34)

When the horn button is pressed, current is supplied through the terminal, coil, contact assembly and yoke. As it passes through the coil, the core becomes magnetized and pulls the armature down. Since the bottom points of the contact assembly is attached to the armature, the points will separate as the armature-shaft assembly is magnetically drawn down. Of course, the moment the points separate, the magnetic field collapses. The armature shaft assembly is lifted back up by the spring tension of the vibrator. As the armature shaft assembly slides back up, the points are again brought into contact and the magnetic coil circuit is completed again. This process is repeated very rapidly. Air vibration from the vibrator is amplified as it funnels through the expansion chamber.



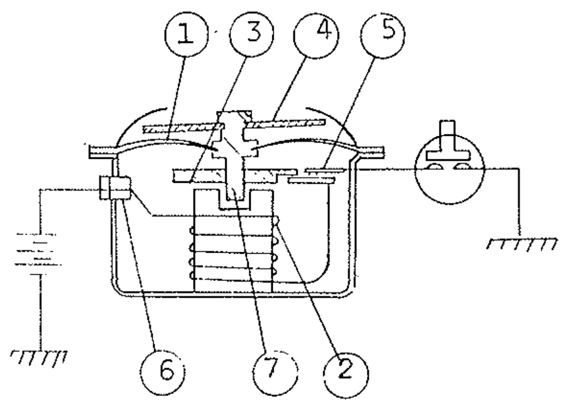
1. Vibrator
2. Coil
3. Armature
4. Resonator
5. Contact Assembly
6. Terminal
7. Shaft

(Illus. 34)

2. Mike type horn: (See Illus. 35)

To vibrate the vibrator, the above system is used. The difference is that when the armature is pulled down, it strikes the end of the core and activates the resonator making a loud sound.

(Illus. 35)



1. Vibrator
2. Coil
3. Armature
4. Resonator
5. Contact Assembly
6. Terminal
7. Shaft

B. Maintenance:

The following three malfunctions are to be checked and adjusted if necessary: does not work, a weak sound, or not uniform.

1. Check by appearance.

a. Dirt in the horn.

b. Water in the horn.

c. Screw is loose or soldering is broken.

d. Points are loose or worn out.

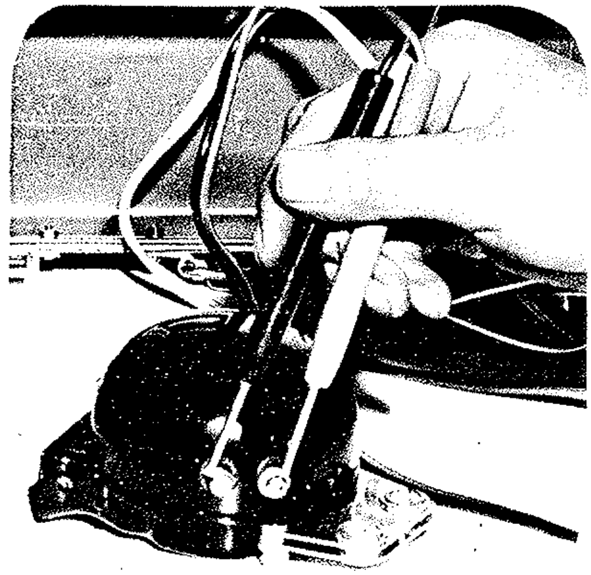
e. Armature-to-core gap is too narrow.

f. The vibrator is broken.

Check the battery and horn button for good operating condition before checking the above.

2. Check the continuity by use of the electro tester. Connect the lead wire to both horn terminals. When there is no continuity, the coil lead wire is broken, or the points are faulty and do not make contact (See Illus. 36).

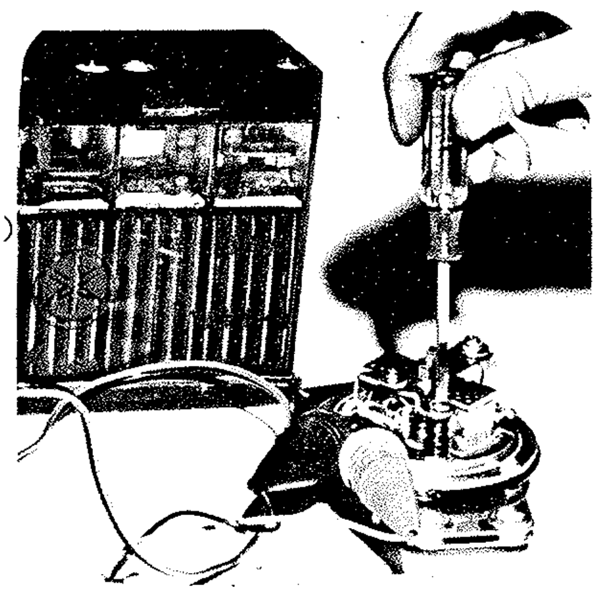
(Illus. 36)



3. Adjusting the horn:

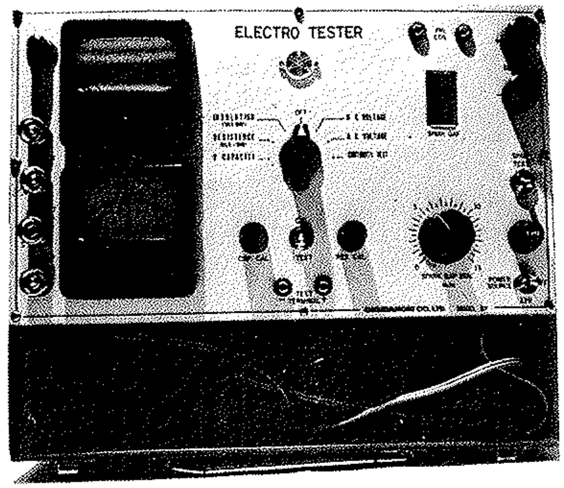
Connect the lead wire from the horn directly to the battery and tighten or loosen the adjusting screw on the horn (See Illus. 37). Normally, when tightening (screw in), the sound becomes louder. When there is no sound, unscrew the adjusting screw until sound is heard, then adjust to tone desired.

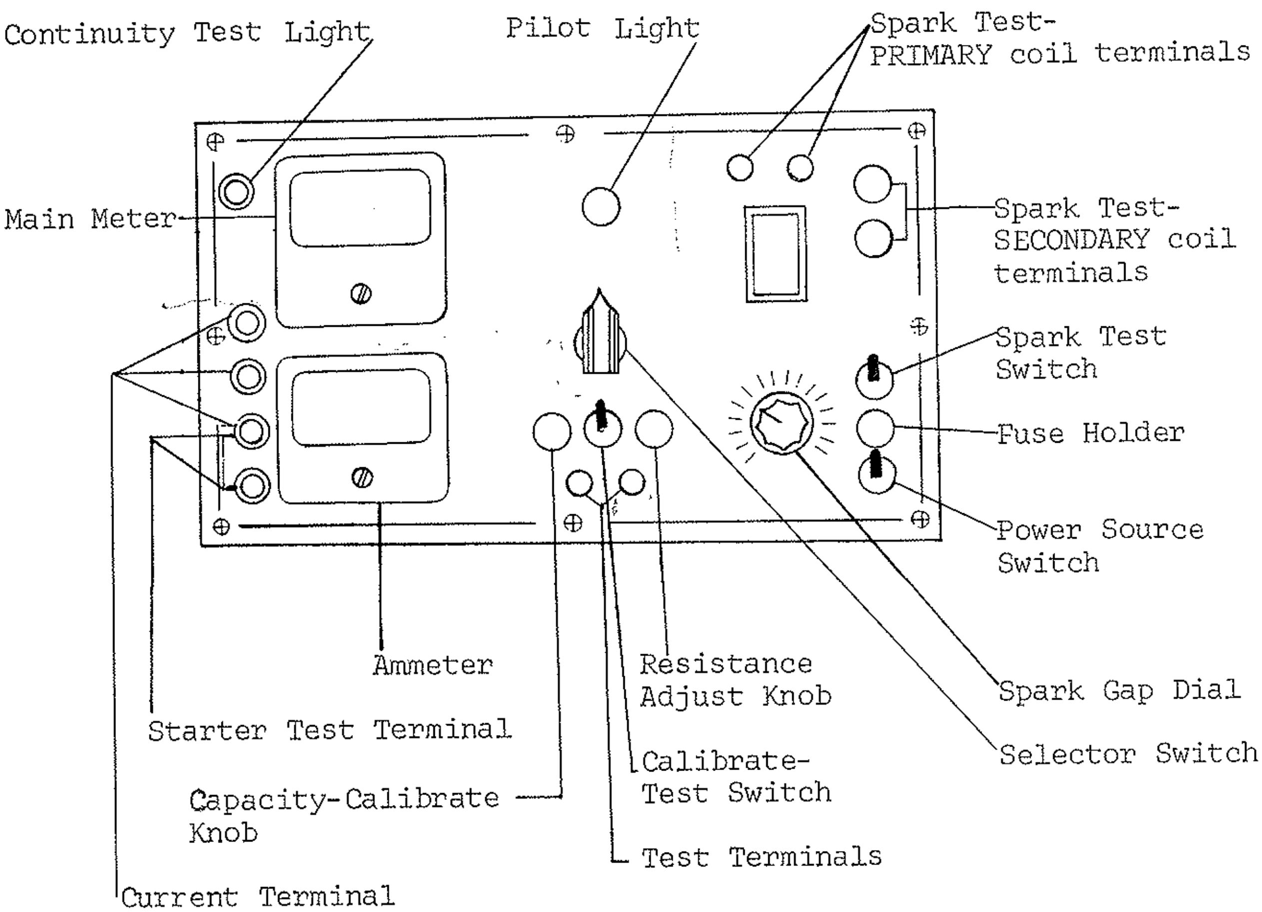
(Illus. 37)



I. ELECTRO-TESTER

When servicing or adjusting any part of the electrical system, refer to the Electrical Specifications section for all specifications or detailed information.





A. Main Tests That Are Possible With the Electro tester

D.C. voltage measurements:	from 0 to 20 volts
A.C. voltage measurements:	from 0 to 20 volts
D.C. current measurements:	from 0 to 5 amps from 0 to 20 amps from 0 to 100 amps (starter motor test only)
Insulation test:	from 0 to 20 megohms
Resistance measurements:	from 0 to 20 kilo-ohms
Condenser capacity measurements:	from 0 to 0.5 microfarads
Ignition coil test:	by adjustable spark gap with third ionizing point.
Continuity test:	by continuity light.
Ignition timing and timing advance:	by timing light.

B. Power Source Hook Up

1. Tests which require a power source:
   a. Insulation test (megohm)
   b. Resistance test (Kilo-ohm)
   c. Capacity test of condenser
   d. Continuity test
   e. Spark test (Ignition coil test)
   f. Timing light

2. Power source voltage: the power source is a 6 or 12 volt battery. The battery in the machine being serviced may be used. Before hooking up the power source, check the battery voltage to be sure the battery has sufficient voltage.

3. Check the position of power source switch: MAKE SURE it is switched to the 6 volt or to the 12 volt position, according to the battery used.

   CAUTION: The unit may be damaged by improper (excessive) voltage.

   When the power source is hooked up, the pilot lamp on the board will light up. If the pilot lamp is not lit, check the lead connection and fuse (5 amps) on the power source.

C. Measurement of Insulation and Resistance

1. Hook up the power source. Switch to proper voltage.

2. Turn the selector switch to "Insulation (megohm)" or to "Resistance (kilo-ohm)."

3. Connect the test leads to the terminals marked "Test Terminal" and clip the free ends together.

4. Zero adjustment: Adjust the "Res. Cal" knob until the pointer of the meter comes to "O" (at the right end of the scale).

5. Unclip the free ends from one another and hook them to the test piece. Watch the main scale for the resistance or insulation reading.

6. A 20 megohm scale is available for measurement of insulation. The Resistance test (kilo-ohm) is used for measurement of internal resistance of the ignition secondary coil.

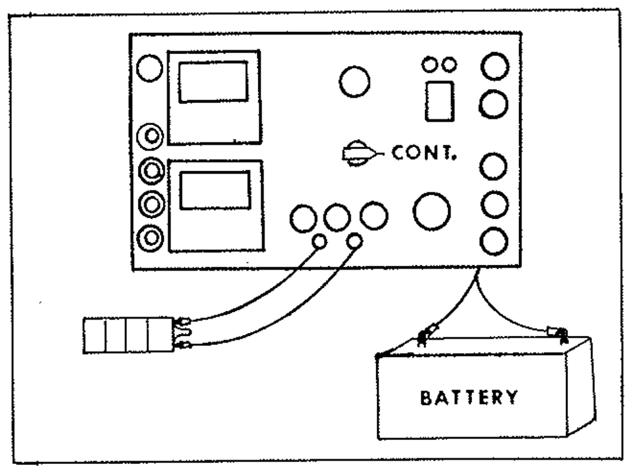
D. Continuity Test

1. Hook up the primary source leads.

2. Turn the selector switch to "CONTINUITY TEST".

3. Attach the test leads to whatever switch, wire, or circuit you are testing.

4. If the continuity lamp lights up, then an unbroken path exists for electricity to flow through--you have continuity between two points.

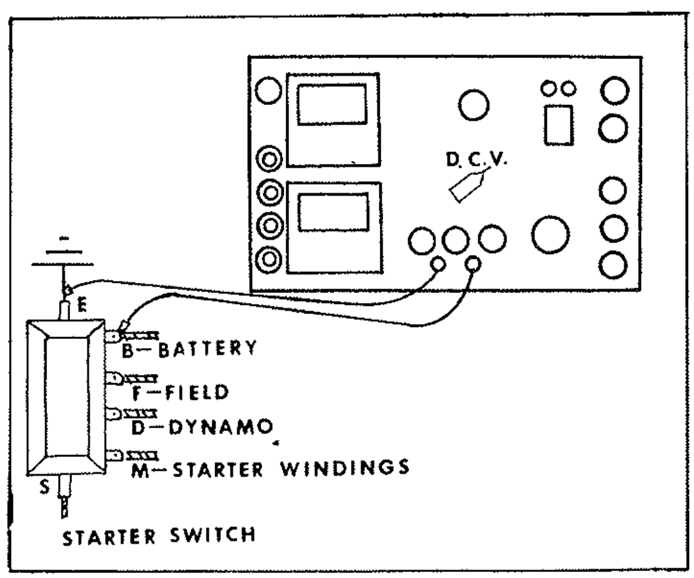


E. Measurement of Voltage Regulator Output

1. Hook up the terminal leads to the regulator, positive to the battery (B) terminal, negative to any suitable ground (E) on the motorcycle.

2. Twist the switch selector to "D.C. Voltage".

3. Start the engine, run it up to the RPM recommended in the electrical specifications sheet, and take a voltage reading off the D.C. voltage scale.



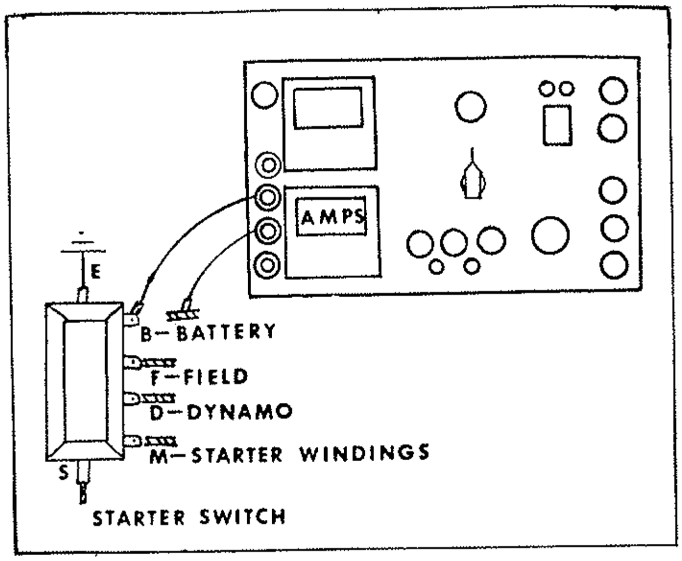
F. Measurement of Current (0-20 A)

1. At the regulator disconnect the wire that leads to the battery.

2. Hook up the amperage leads as shown in the illustration.

3. With the engine dead and the switches off, check the ammeter for a reading. There should be no amperage draw. If there is, it is an indication of a short in the electrical circuit.

3. Start the engine and check the ammeter again. This will provide you with the total amperage being used by the electrical circuit in operation.



G. Condenser Test

1. Insulation Test

   a. Measure insulation using the megohm scale mentioned in Paragraph 2D (Insulation Test). Connect the two leads to the pigtail and the housing of the condenser to be tested. The pointer of the meter will move to the right and then slowly return to the left. Keep the connection until the pointer comes to a stop.

   b. Read the pointer on the megohm scale. When it shows 5 megohms or over, the insulation is satisfactory.

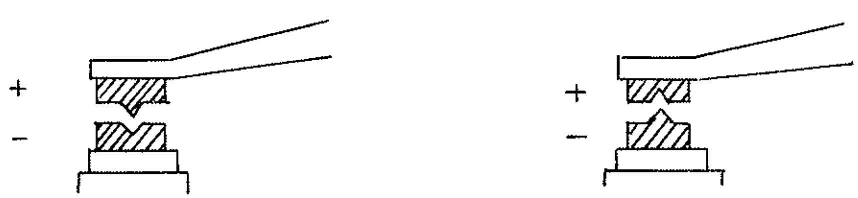
   NOTE: Immediately after this test, the tested condenser is charged with 500 volts, so discharge it by grounding the pigtail to the housing.

2. Measurement of capacity (Microfarads)

   a. Turn the selector switch to "C-Capacity".

   b. Flip the "Cal-Test" switch up.

CONDITION OF CONTACT POINTS WITH A FAULTY CONDENSER



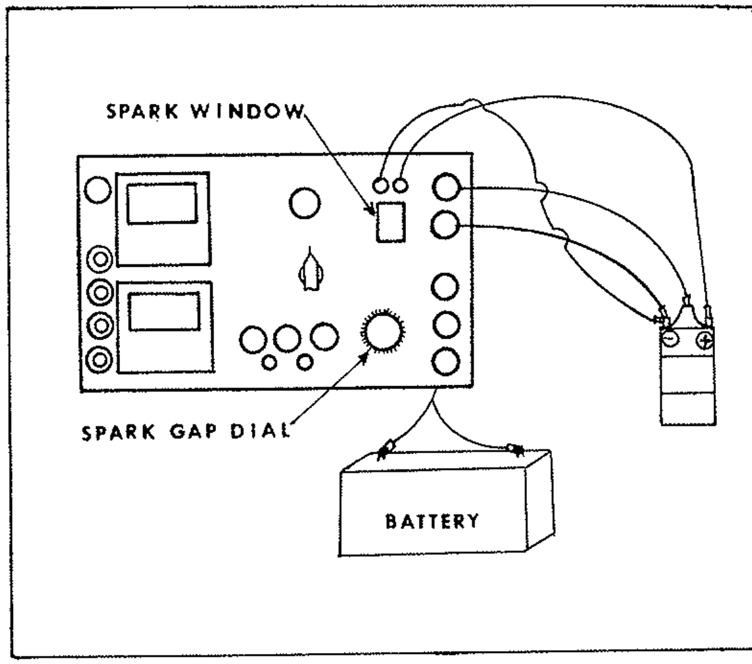
Low Capacity

Excessive Capacity

c. Set the meter needle to point to .22 on the microfarad scale (standard rating on all Yamaha condensers).

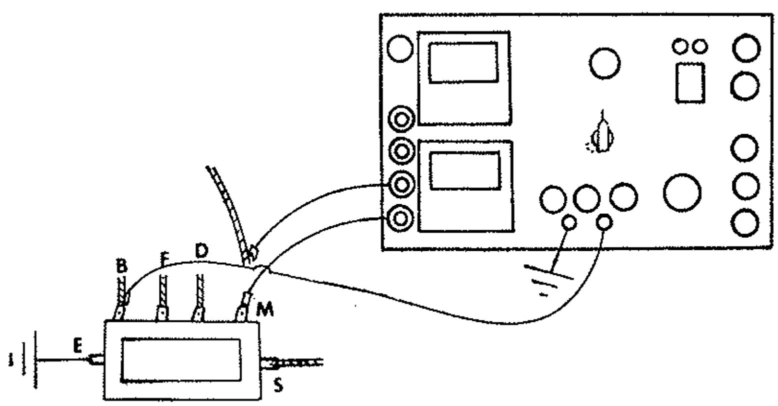
d. Insert the test leads into the "Test-Terminals" of the tester. Clamp the free test lead ends to the condenser pigtail wire and the housing. Flip the "Cal-Test" switch down and watch the needle. The condenser is still working correctly if the needle bounces and then returns to .22 microfarads.

H. Spark Test (Ignition coil test)



1. Connect the Electro Tester to a power source.
2. Hook up the leads to the ignition coil as shown in the drawing.
3. Flip the spark test switch up.
4. Twist the spark gap dial, causing the tester electrode tips to draw away from each other. Check the dial for the distance in millimeters when the spark stops jumping the distance between the electrode tips.
5. After completing this test, flip the spark test switch down.
6. An ignition coil that puts out a minimum spark length of 6mm is considered to be functioning correctly.

I. Starter Test



1. Connect a separate tachometer (electric type) to the test engine and hook up the Electro Tester as shown in the drawing to measure:

   a. Start RPM
   b. Current draw of the starter motor.
   c. Terminal voltage of the battery

2. Set the selector switch, push the starter button, and observe:

   a. The revolutions should reach 400 RPM or more.

   b. The current draw will be 100 Amps or more for a moment and then drop down to 20-50 Amps.

   c. The voltage will drop to approximately 8 volts for a moment and then come back up to 10-10.5 volts or more.

3. Troubleshooting the starter:

   a. If the starter RPM drops lower than that specified-

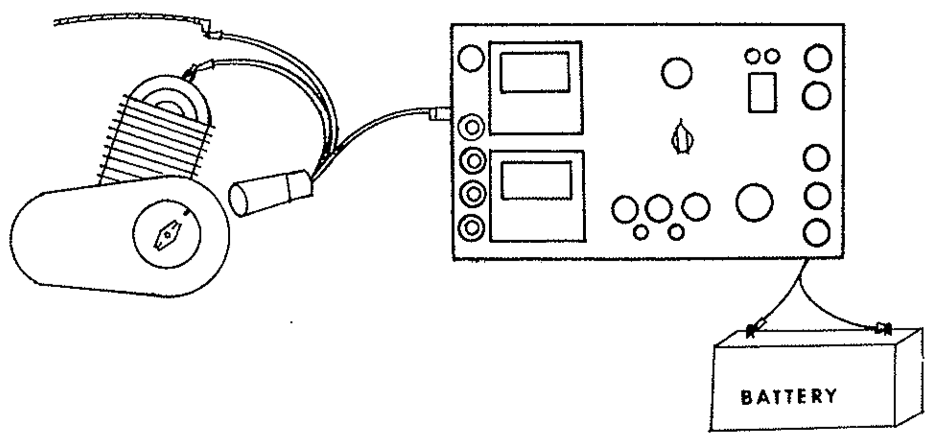
      (1) The starting current is too high. There is a short circuit.
      (2) The starter current is too low. There is a disconnection or poor contact in the circuit.
      (3) The capacity of the battery is too small.

   b. Starter RPMs are correct but the engine does not start:

      (1) Weak spark. Trouble in the ignition coil or condenser.
      (2) Strong spark. Trouble in the fuel system or the spark plug.

4. In the case of new machines, start the inspection work by checking the battery capacity. Checking electrical equipment should always begin with the power source.

J. Strobe Light (Timing light)



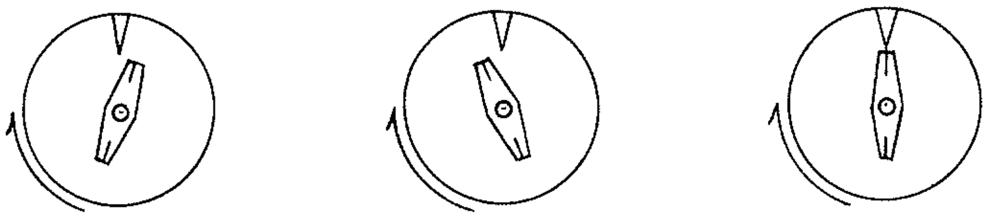
1. Determination of ignition timing variations.

   NOTE: All Yamaha machines must be timed with a dial indicator and point checker. The purpose of the strobe light is to check for abnormal operation during dynamic (running) conditions.

   a. Hook up the power source and the timing light as shown in the drawing.

b. With the engine running, the synchronized flashes of the timing light cause the rotating timing mark to appear to be in a stationary position. The rotating timing mark can now be visually checked to see if it lines up with the stationary timing mark.

c. Ignition timing is late (retarded) when the rotating mark is past the stationary mark, considering that the mark moves in the direction of crankshaft rotation; ignition timing is early (advanced) when the rotating mark is lit up before reaching the stationary mark.



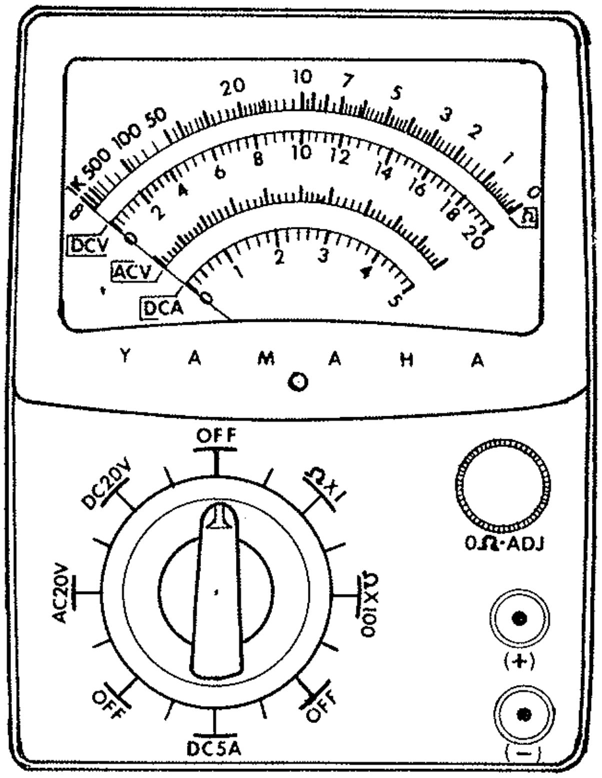
FIRING LATE (RETARDED) | FIRING EARLY (ADVANCED) | CORRECT TIMING

d. When the revolutions of an engine equipped with an automatic advance system are increased in steps, the timing mark will move in an "advanced" direction until the engine timing reaches a fully advanced position. All Yamaha timing specifications and timing marks must be at the fully advanced position.

2. Checking for identical timing between cylinders of a twin cylinder engine:

TIMING IMBALANCE BETWEEN TWO CYLINDERS | BOTH CYLINDERS TIMED RIGHT

II. POCKET TESTER



ΩX 1 ———— Used for checking continuity of generator, regulator and coil, setting ignition timing and small resistance checks.

ΩX 100 ———— Used for measuring insulation leakage such as generator and ignition coil, and checking other large resistance.

DC 20V ———— Used to check the voltage output of generators and regulators and batteries.

AC 20 ———— Used to check the voltage output of magnetos.

DC 5A ———— Used to check DC current output from generators, magnetos, rectifiers, regulator, etc.

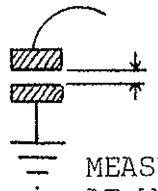
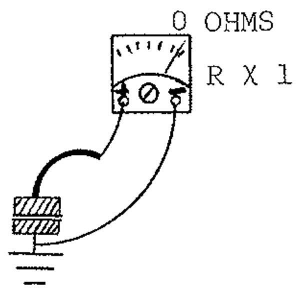
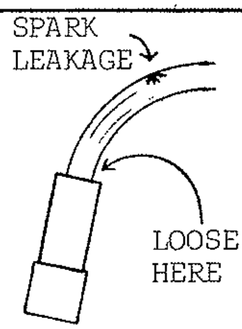
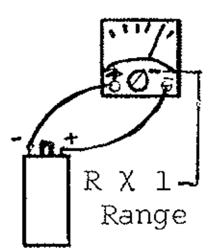
NOTE: BEFORE ANY RESISTANCE MEASUREMENTS CAN BE MADE, THE METER MUST BE ZEROED. THIS IS DONE BY SHORTING THE ENDS OF THE TWO LEADS TOGETHER AND TURNING THE OHMS ADJUST KNOB UNTIL THE NEEDLE READS ZERO.

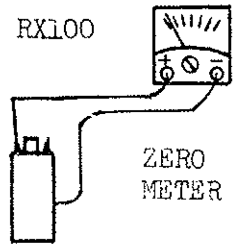
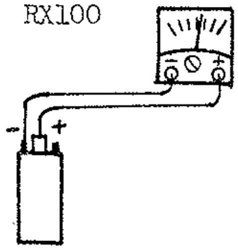
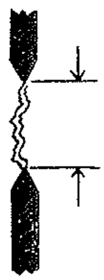
WIRING COLOR CODE FOR ALL MACHINES

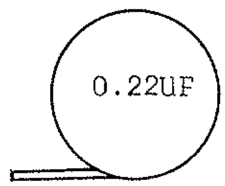
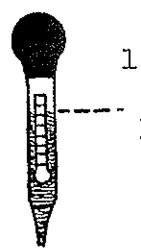
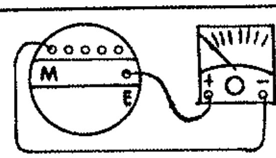
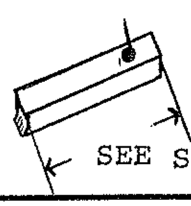
RED --------------------------------BATTERY
LIGHT GREEN (heavy)----------------STARTER MOTOR
GREEN-------------------------------FIELDS
WHITE-------------------------------ARMATURE
BLACK-------------------------------GROUND (E)
ORANGE------------------------------IGNITION (Gray also if twin)
BROWN-------------------------------SOURCE (Current if switch is on)
DARK BLUE---------------------------LIGHTS
GRAY--------------------------------IGNITION ON TWINS
YELLOW------------------------------BRAKE LIGHT
BLUE AND WHITE----------------------STARTER BUTTON
BROWN AND WHITE---------------------FLASHER RELAY
PINK--------------------------------HORN BUTTON
DARK GREEN--------------------------TURN INDICATOR
DARK BROWN--------------------------TURN INDICATOR

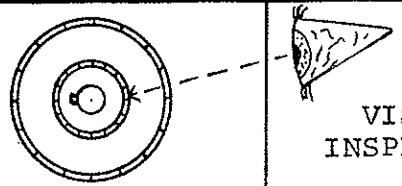
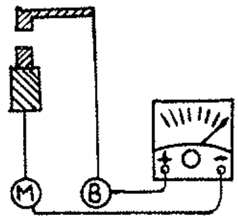
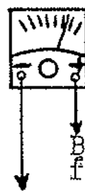
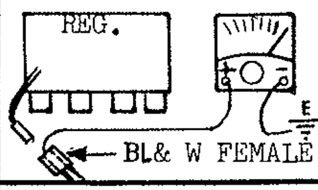
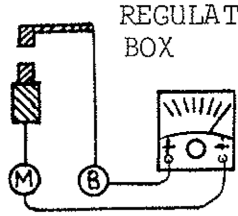
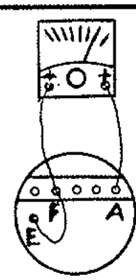
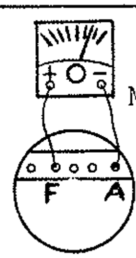
COMMON SYMBOLS FOR MOTORCYCLE ELECTRICAL COMPONENTS

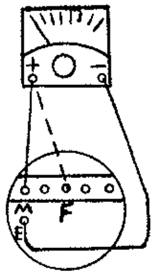
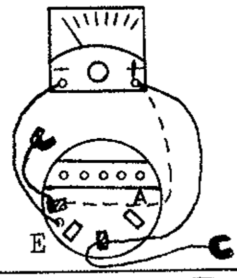
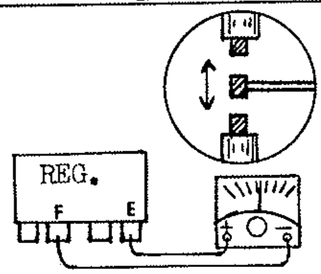
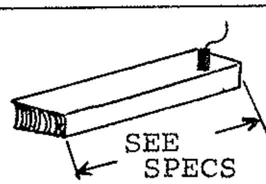
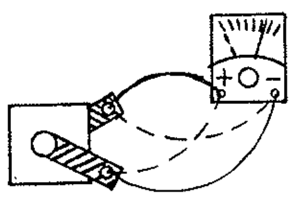
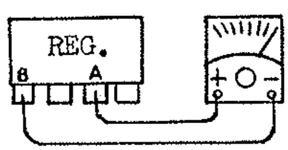
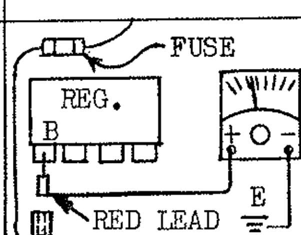
C--------COMMUTATOR   B--------BATTERY   A--------ARMATURE
F--------FIELD   E--------GROUND (earth).   M--------MOTOR (Starter)

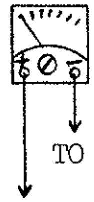
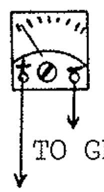
PROBLEM	CAUSE	INSPECTION METHOD	TOOL	REMARKS
	BAD PLUG	VISUAL INSPECTION	SPARKPLUG WRENCH	REPLACE
	INCORRECT POINT GAP	 MEASURED AT WIDEST OPENING	FEELER GAUGE	RESET
	DIRTY POINT SURFACE		POCKET TESTER ZERO METER	MUST READ ZERO OHMS WITH POINTS CLOSED CLEAN POINTS
NO SPARK	DAMAGED PLUG WIRE OR LOOSE PLUG CAP WIRE		VISUAL INSPECTION INSPECT BY HAND	RESEAT PLUG CAP WIRE
	NO CONTINUITY BETWEEN THE NEGATIVE ⊖ AND POSITIVE ⊕ IGNITION COIL TERMINALS		POCKET TESTER ZERO METER	SEE SERVICE SPECS FOR CORRECT READING

PROBLEM	CAUSE	INSPECTION METHOD	TOOL	REMARKS
NO SPARK	BAD PRIMARY WINDING IN IGNITION COIL	RX100  ZERO METER	POCKET TESTER ZERO METER	MUST READ INFINITE REPLACE COIL
	BAD SECONDARY WINDING IN IGNITION COIL	RX100 	POCKET TESTER ZERO METER	SEE SERVICE SPECS FOR CORRECT MAGNETO OR GENERATOR READING REPLACE COIL
	INSUFFICIENT COIL OUTPUT	 AT LEAST 6mm	ELECTROTESTER	REPLACE COIL IF SPARK GAP IS LESS THAN 6mm
MISFIRE AT HIGH R. P. M.	SPARK PLUG TOO HOT		VISUAL INSPECTION	ELECTRODE WHITE, GRAY OR BLISTERED REPLACE WITH COLDER PLUG
	SPARK PLUG TOO COLD		VISUAL INSPECTION	ELECTRODE DARK BROWN, BLACK OR OIL FOULED REPLACE WITH HOTTER PLUG
	SPARKPLUG DIRTY		VISUAL INSPECTION	CLEAN OR REPLACE PLUG

PROBLEM	CAUSE	INSPECTION METHOD	TOOL	REMARKS
MISFIRE AT HIGH R. P. M.	WEAK BREAKER POINT SPRING	INSPECT MANUALLY	FINGERS OR TENSION GAUGE	REPLACE
	INCORRECT IGNITION TIMING	INSPECT MANUALLY	DIAL INDICATOR AND POINT CHECKER	RESET
EXCESSIVE SPARK JUMP ON POINT SURFACE	ROUGH POINT SURFACE	 ROUGH	VISUAL INSPECTION	SMOOTH WITH EMERY PAPER
	DIRTY POINT SURFACE	 DIRTY	VISUAL INSPECTION	CLEAN WITH LACQUER THINNER
	WRONG CONDENSER VALUE	 0.22UF	ELECTRO TESTER	SEE MANUAL FOR CORRECT VALUE REPLACE
STARTER MOTOR DOES NOT WORK	BATTERY DISCHARGED	 1.25 or less	HYDROMETER	RECHARGE BATTERY to 1.26 - 1.28
	SHORTED MOTOR CIRCUIT	 R X 100 RANGE	POCKET TESTER ZERO METER	DISCONNECT 'M' WIRE FROM YOKE SHOULD READ INFINITE WITH BRUSHES OFF
	WORN BRUSHES	 SEE SPECS	CALIPERS	SEE SERVICE SPECS FOR CORRECT LENGTH AND TOLERANCE

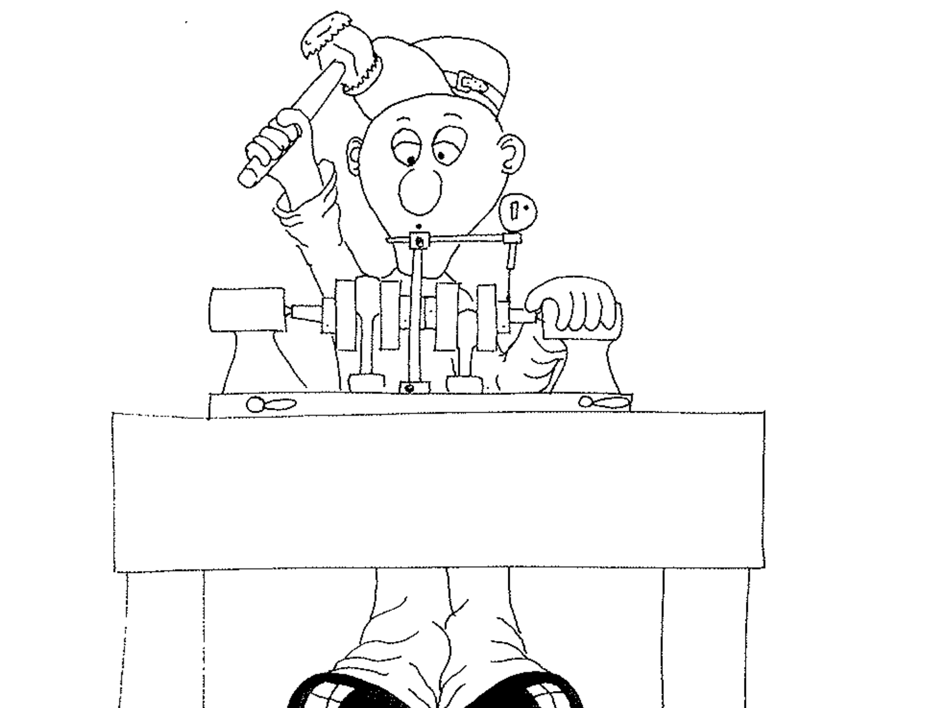
PROBLEM	CAUSE	INSPECTION METHOD	TOOL	REMARKS
STARTER MOTOR DOES NOT OPERATE CORRECTLY	COMMUTATOR WORN OUT		VISUAL INSPECTION	REPLACE OR TURN DOWN
	NO CONTINUITY BETWEEN BATTERY AND MOTOR	STARTER SWITCH IN REGULATOR BOX 	POCKET TESTER R X 1 RANGE	MUST READ ZERO OHMS WITH CON- TACTS CLOSED
	STARTER WINDINGS BROKEN		POCKET TESTER R X 1 RANGE ZERO METER	SEE SERVICE SPECS FOR CORRECT READING
	NO CONTINUITY BETWEEN STARTER BUTTON AND GROUND		POCKET TESTER R X 1 RANGE POS.- TO BLUE & WHITE FEMALE NEG.- TO GROUND	CLEAN POINTS WITH LACQUER THIN- NER, & EMERY #400 SHOULD READ ZERO OHMS.
STARTER MOTOR WILL NOT STOP	STUCK STARTER RELAY	STARTER SWITCH IN REGULATOR BOX 	POCKET TESTER R X 1 RANGE	CLEAN POINTS WITH LACQUER THINNER AND EMERY #400 SHOULD READ INFINITE WITH POINTS OPEN
GENERATOR DOES NOT CHARGE	CHECK VOLTAGE OUTPUT FROM GENERATOR (DYNAMO) GROUND FIELD WITH JUMPER WIRE FROM 'F' TO 'E'		POCKET TESTER DC20V RANGE DO NOT EXCEED 2500 RPM	DISCONNECT 'F' & 'A' WIRES. SEE SERVICE SPECS FOR CORRECT RPM AND READING
	BROKEN FIELD COIL		POCKET TESTER R X 1 RANGE REMOVE ARMATURE AND FIELD WIRES LIFT OFF BRUSHES	SEE SERVICE SPECS FOR CORRECT READING

PROBLEM	CAUSE	INSPECTION METHOD	TOOL	REMARKS
GENERATOR DOES NOT CHARGE	GROUNDED FIELD OR MOTOR COIL		**POCKET TESTER** R X 100 RANGE NEG.- TO GROUND	SHOULD READ INFINITY DISCONNECT ALL WIRES AND LIFT OFF BRUSHES
	GROUNDED +(POS) BRUSH HOLDER		**POCKET TESTER** R X 100 RANGE	SHOULD READ INFINITY DISCONNECT BRUSH LEAD WIRES FROM ARMATURE TERM. & LIFT BRUSHES FROM ARMATURE
	BROKEN REGULATOR FIELD COIL		**POCKET TESTER** R X 1 RANGE HOLD MOVING POINT CENTERED	**SEE SERVICE SPECS FOR CORRECT READING**
	BRUSH LENGTH TOO SHORT		CALIPERS	**SEE SERVICE SPECS FOR CORRECT LENGTH & TOLERANCE**
	CHECKING RECTIFIER FOR REVERSE CURRENT FLOW		**POCKET TESTER** R X 100 RANGE CHECK READING THEN REVERSE LEADS.	**SHOULD READ LOW RESISTANCE CHANGE LEADS, SHOULD READ INFINITY**
	BROKEN CUT-OUT RELAY COIL		**POCKET TESTER** R X 1 RANGE CLOSE CUT-OUT RELAY POINT	**SEE SERVICE SPECS FOR CORRECT READING**
	CHECK VOLTAGE OUTPUT FROM REGULATOR (No Load)		**POCKET TESTER** DC 20V RANGE, DISCONNECT RED LEAD FROM REGULATOR, (+) TO RED LEAD	**SEE SERVICE SPECS FOR CORRECT RPM & READING**

PROBLEM	CAUSE	INSPECTION METHOD	TOOL	REMARKS
FUSE BLOWS WHEN IGNITION SWITCH IS TURNED ON	SHORT IN BROWN WIRE	 TO GROUND TO BROWN WIRE DISCONNECT CHARGING LIGHT TURN IGNITION <u>OFF</u> HOLD IGNITION POINTS OPEN	**<u>POCKET TESTER</u>** R X 1 RANGE	OHM METER MUST READ INFINITE RESISTANCE
FUSE BLOWS WHEN LIGHTS ARE TURNED ON	SHORT IN LIGHTING CIRCUIT	 TO GROUND TO DARK BLUE WIRE DISCONNECT YELLOW AND GREEN HEAD-LIGHT WIRES REMOVE TAILLIGHT BULB	**POCKET TESTER** R X 1 RANGE	METER MUST READ INFINITE RESISTANCE

YAMAHA

CRANKSHAFT REPAIR



CRANKSHAFT REPAIR

CRANKSHAFT REPAIR

INTRODUCTION

When it is necessary to tear down a crankshaft because of a part failure, you must consider the parts that have collapsed in connection with the total amount of parts that should be replaced. Remember that each crankshaft includes crank wheels, crank pins, big end bearings, center seals, and center main bearings. They function as a unit, and therefore, failure of one part could quite possibly weaken others. For example, if the big end bearings fail, the crank pin and connecting rod big end must also be thoroughly examined for score marks or any other signs of damage, no matter how slight. Do not hesitate to replace any parts, as described just previously, which indicate a possibility of premature failure. This will help to protect you, the mechanic and dealer, from unnecessary 'come back' work due to a part within a rebuilt crankshaft collapsing after short mileage.

There are four major pieces of equipment needed to rebuild a crankshaft. They are:

(1) a complete crankshaft servicing jig
(2) a crankshaft separator
(3) a press
(4) a centering device to check for crankshaft run-out

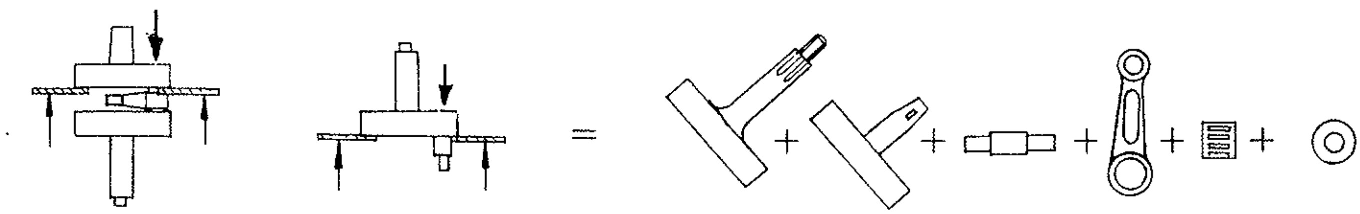
The complete jig set and the separator can be purchased from Yamaha International. The press and the centering device should already be standard equipment, and in use, in the shop. If a special purchase is necessary to obtain a centering device, then a small, inexpensive lathe, even a wood lathe, would meet the crankshaft requirements because no means to rotate the lathe centers is needed.

To aid in understanding the disassembly and the reassembly procedures, the entire procedure has been broken down into separate steps and explained by these schematic drawings pictured on the next page.

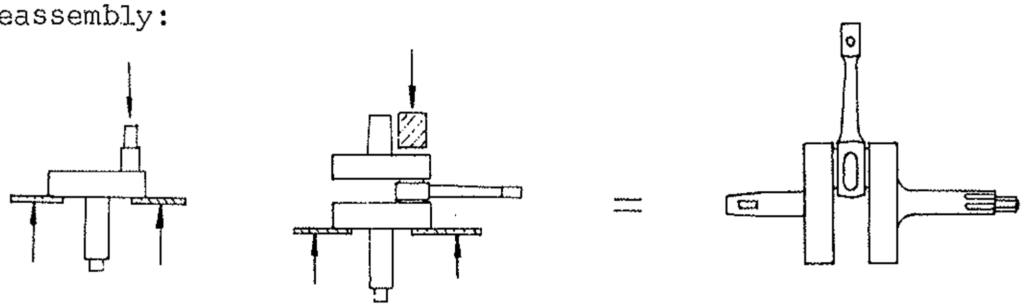
Disassembly requires two pushes of the press. Realignment consists of a little tapping with a lead or brass hammer. Schematically, it looks like this:

When ↓ = pressure head and ↑ = support, then:

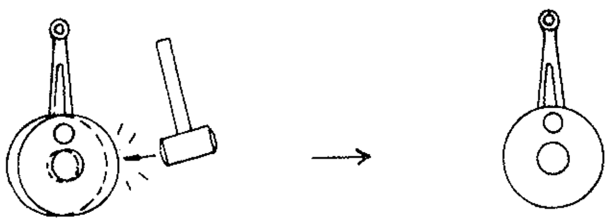
Disassembly:



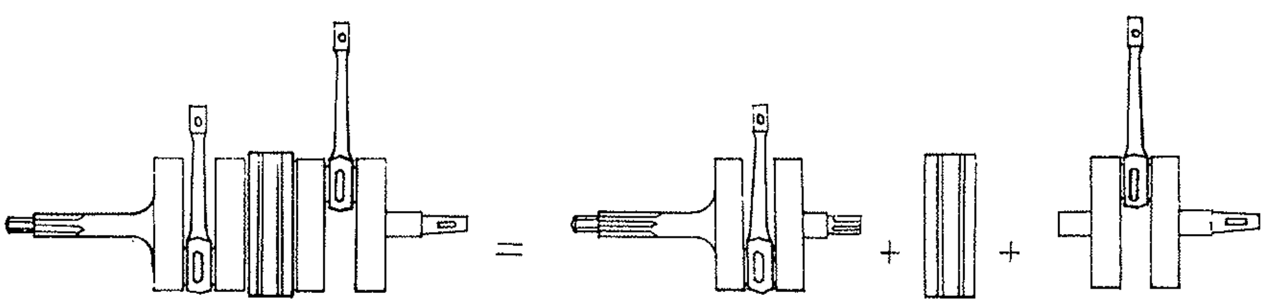
Reassembly:

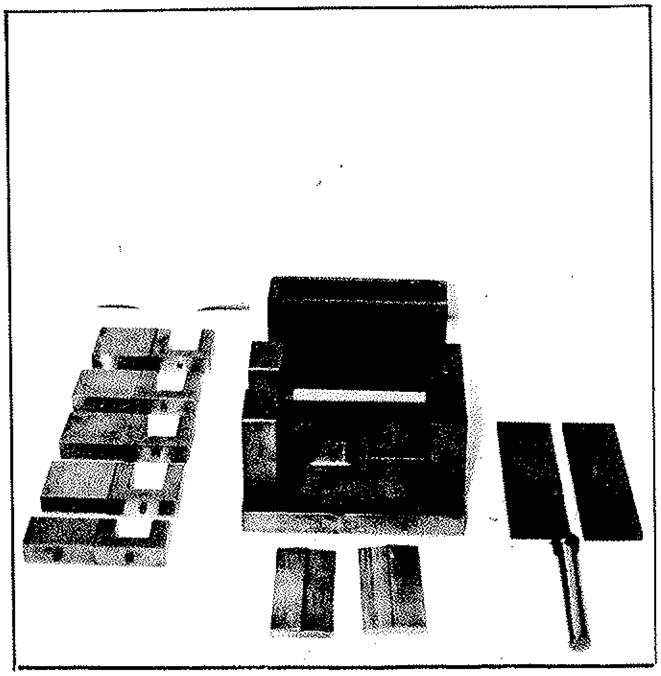


Alignment:

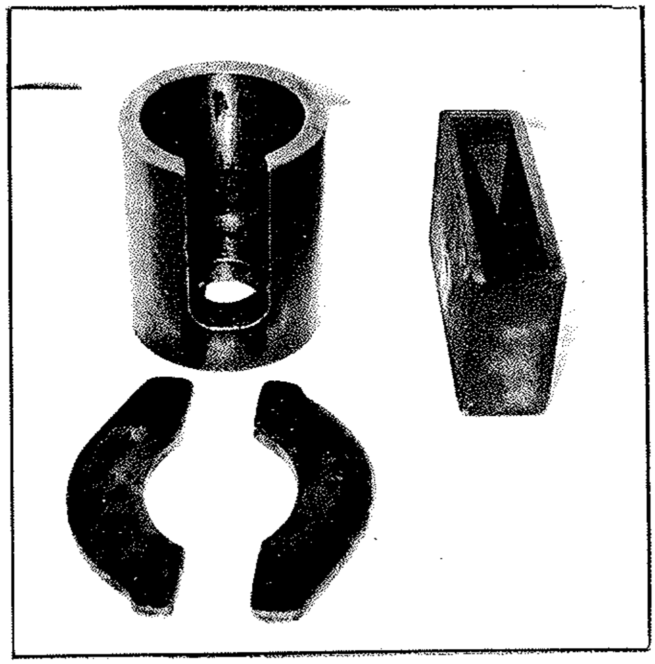


Twin cylinder crank halves are designed with spline fittings to make reassembly very easy. Just line up the two parts by sight with the crank pins 180° opposite and press them together. Twin cylinder alignment consists of first treating each side as a single, and then later making an alignment check on the whole unit. Or to put it schematically again:





NEW STYLE



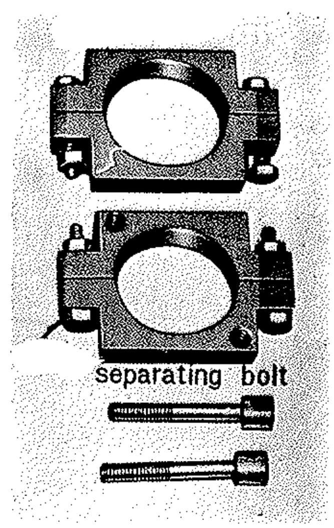
OLD STYLE

Crankshaft Separator
(Common to both jigs)

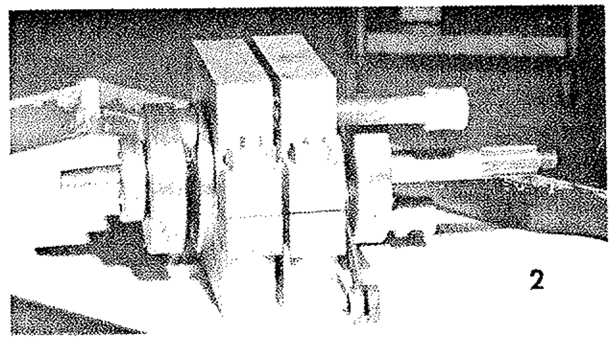
To separate the two halves of a twin cylinder crankshaft, another Yamaha tool is needed. This tool is the crankshaft separator. The separator comes in four sizes to suit the different crankshaft sizes.

a) 100-125cc
b) 180cc
c) 250-305cc
d) 350cc

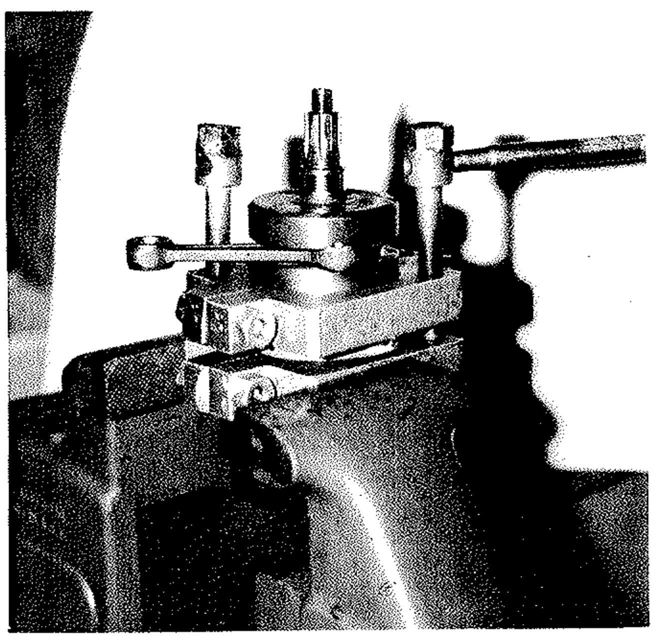
The procedure for using all these tools is identical. Pictured is the separator with its associated parts.



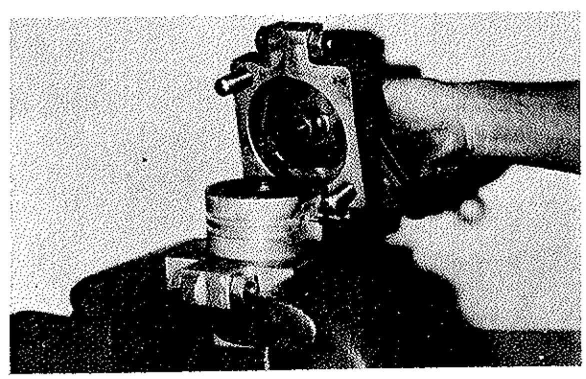
1..Crankshaft ready for disassembly. Bottom half of one side of separator is in place.



2..Separator in place. Use a soft hammer to firmly tap the two halves of the separator together. This, together with constant tightening of the clamp bolts with a wrench, ensures that the separator lips will solidly grip the crank wheels and will avoid snapping the lips off during dis-assembly.



3..Separator in operation. To separate evenly, turn the bolts alternately, ½ turn at a time.

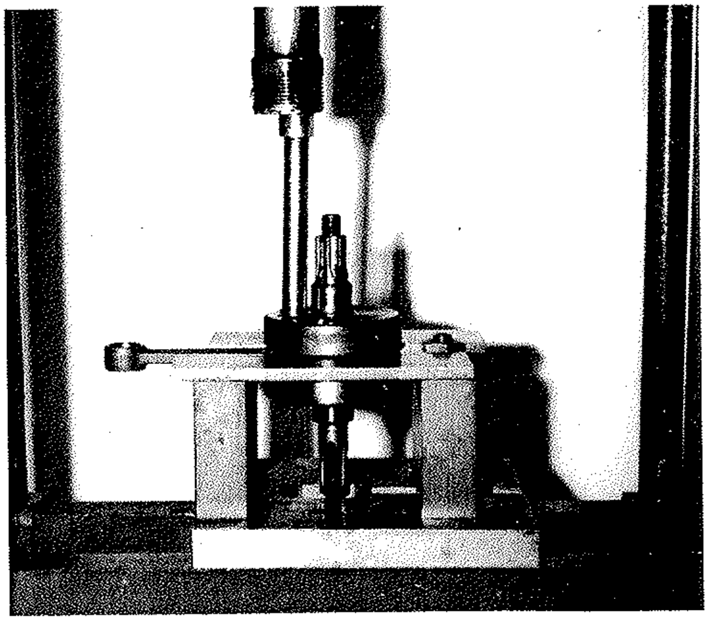


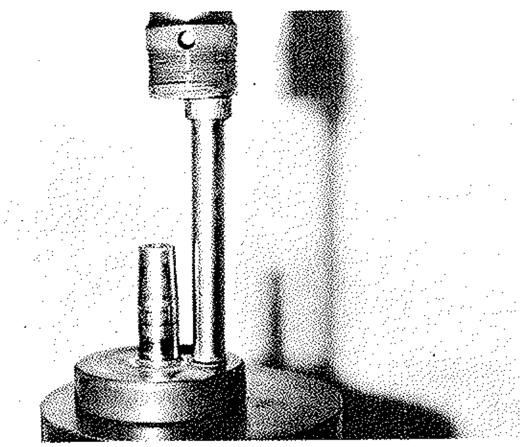
4..The two crank halves pulled apart. For later assembly reference, note that one crank half has two female ends, and the other half has two male splines.

NOTE:
WHEN VIEWING THE DISASSEMBLY AND REASSEMBLY STEPS (1 THRU 17), YOU WILL NOTICE THAT THE PICTURES SOMETIMES SHOW A SHOT OF THE NEW JIG, SOMETIMES THE OLD JIG. THE TWO ARE COMBINED TO AVOID UNNECESSARILY REPEATING THE SAME INSTRUCTIONS TWICE SINCE THE METHOD OF USAGE IS BASICALLY THE SAME EXCEPT FOR THE DIFFERENCE IN DESIGN OF THE JIGS THEMSELVES.

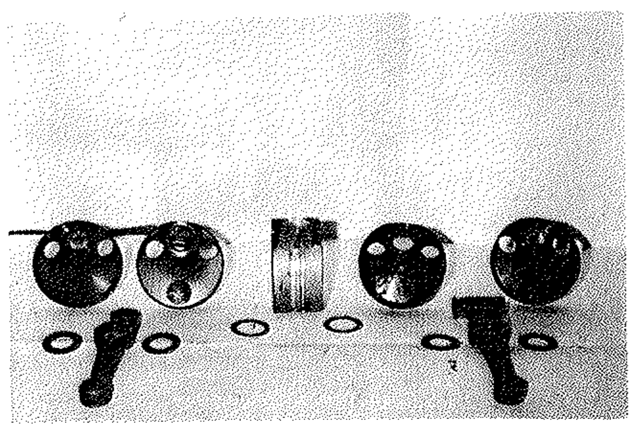
5..Place the jig body in the press. Install the two press plates between the crank wheels, as shown, and set the crankshaft on the jig body. Take note of the slot in the jig body designed to accept the crankshaft connecting rod. Place the press pin against the crank pin that is located in the upper crank wheel. Push the crank pin out.

NOTE: be sure the connecting rod is in the special slot and also make sure that pressure is applied straight down. It is best to have the moveable alignment block up tight against the lower crank wheel to relieve the strain on the press plates.

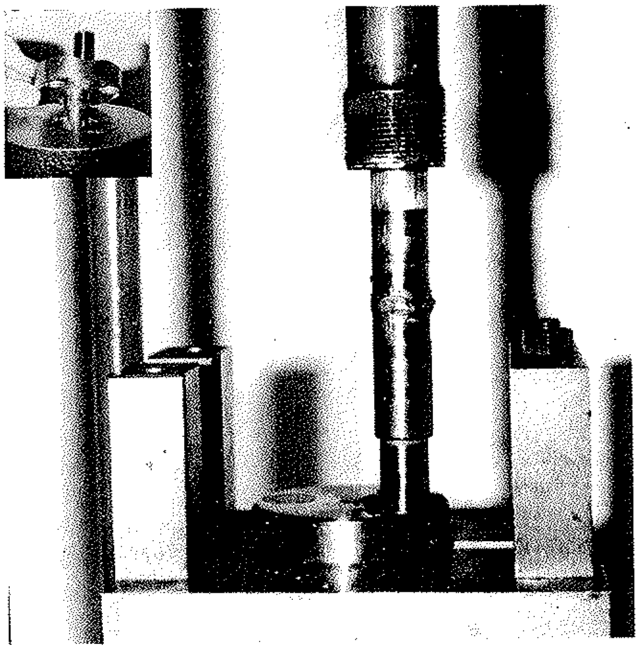


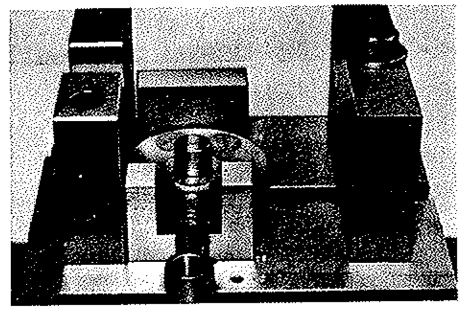


6..Support the second wheel and push the pin out. This completes the disassembly of a single cylinder crankshaft or one half of a twin.



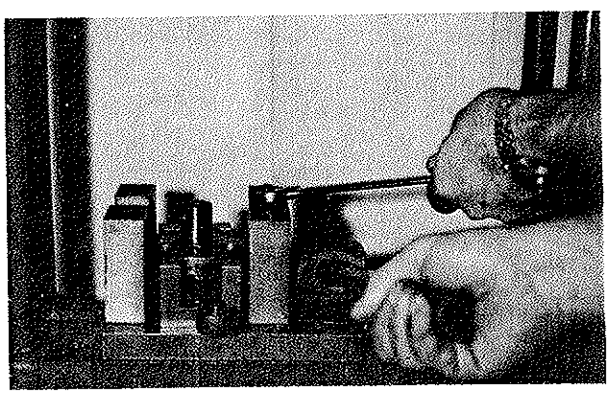
7..Repeat the last two steps on the other crank half to complete the teardown of a twin cylinder type. This shows the crankshaft as it will look after you have completed the disassembly.



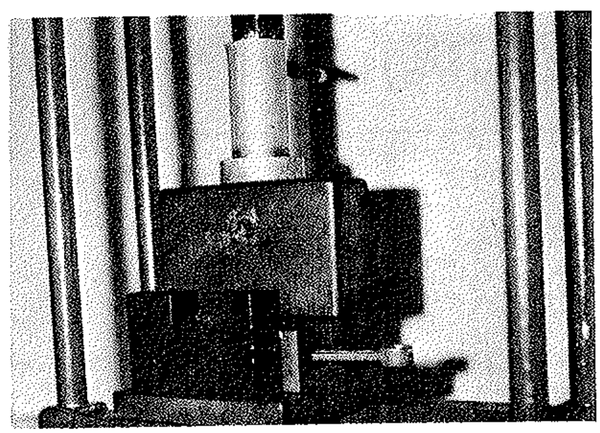


8..Begin reassembly by pressing a new crank pin into the crank wheel. When doing this operation, be sure to push the pin straight down to avoid galling the hole. Note the picture insert showing a shim under the wheel which acts to stop the pin from being pushed too far.

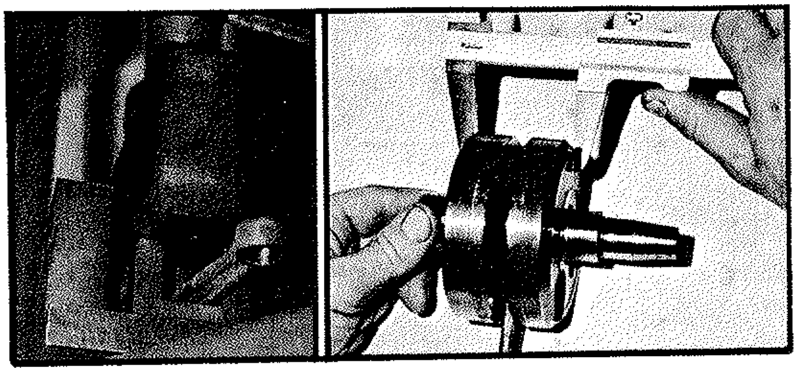
9..Place the crank wheel, spacers, crank pin bearing, and connecting rod in the jig. Take note of the slot in one stop designed to accept the connecting rod.



10..Place the other wheel in position and lightly tap it onto the crank pin to keep the wheel in a horizontal position. Push the sliding block up against the wheel assembly, tapping it a couple times with a soft hammer to line up the two wheels, and finish by tightening the sliding block.



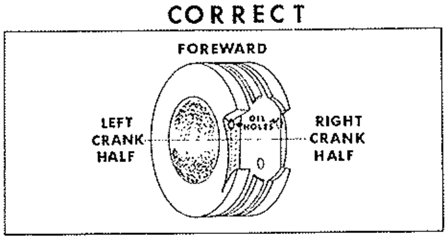
11..Next, place the press box on top of the upper crank wheel. (You will notice that a large diameter pin is placed between the press and the press box. Since the press box is hollow, this pin is necessary to keep from pushing a hole through the press box). Begin to press the crank wheel onto the pin.



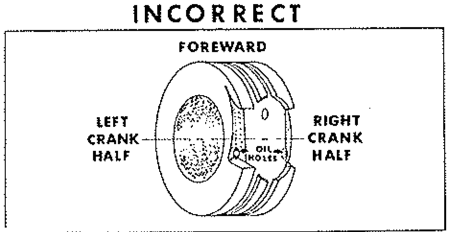
12..Push down on the press box, directly over the crank pin, until it firmly comes in contact with the two stops. The overall width of the wheels should now be correct (check with a vernier caliper to make sure). If the old type jig is used, it will be necessary for the crank assembly to be removed several times and the total width measured to finally arrive at the correct width as specified in the <u>CRANKSHAFT DATA</u> section.

If it is a twin cylinder type crankshaft, the last five steps will have to be repeated to reassemble the other crank half.

CORRECT

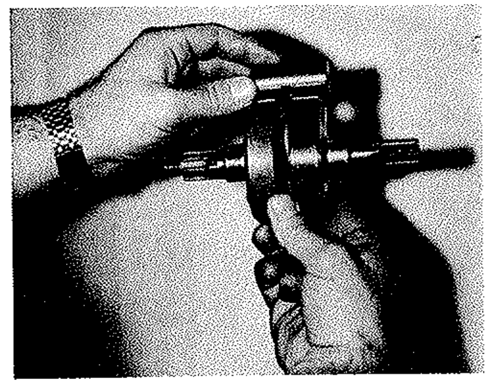


INCORRECT

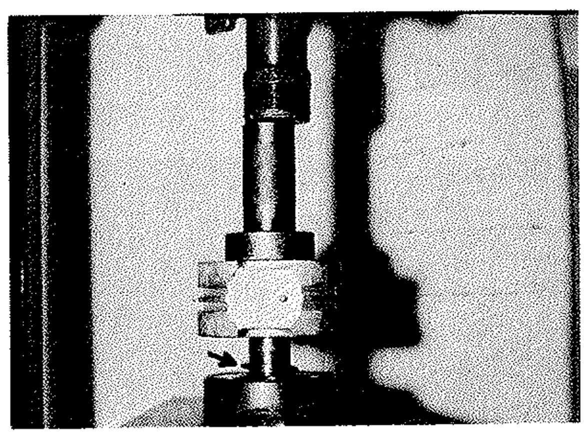


14..Position the center block correctly before pressing it onto the shaft. The oil holes must be positioned foreward of the crankshaft centerline.

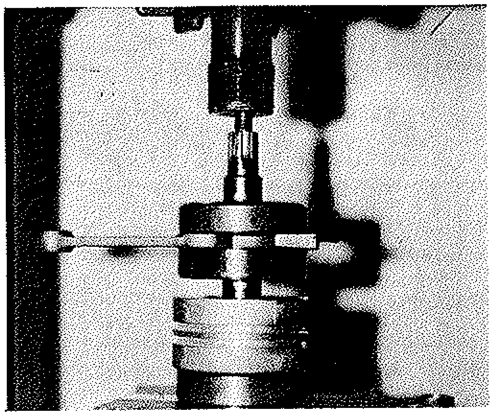
It is very possible that the center block has to be rebuilt before it is pressed back onto the crankshaft. If this step is necessary, then turn to the <u>REPLACING CENTER BLOCK BEARINGS AND SEAL</u> section for the correct procedure.



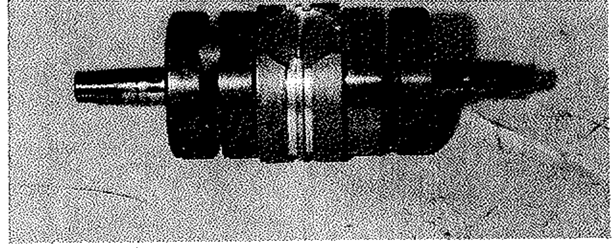
13..After pressing the two crank wheels together, check the assembled crank half for rough aligmment. Lay a good crank pin (accurately machined surface) across the edge of both wheels. Make this test around the entire rim of the assembly. If the wheels are aligned with each other, the pin will touch all the way across the surfaces of both wheels. Light between one wheel and the crank pin indicates one wheel to be higher than the other. Use a soft hammer to tap the wheels into alignment (see section on <u>ALIGNMENT</u> for picture of procedure).

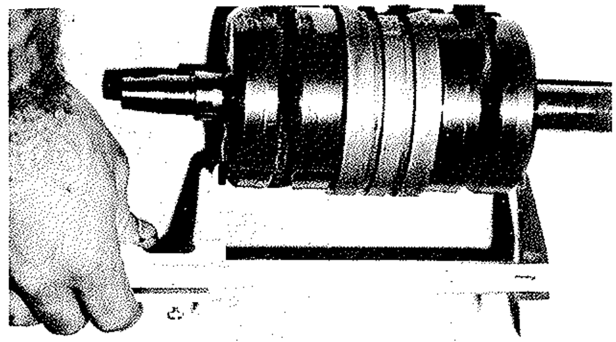


15..Press the center block onto the crank half. Be sure that support plates are fitted under the <u>top</u> wheel of the bottom crank half to prevent the wheels from being forced together. Also check for the crank shim to be included between the wheel and the center block.



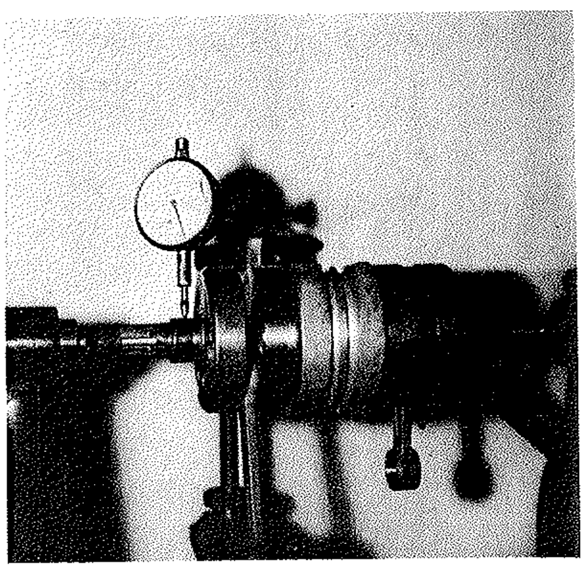
16...As in the previous step, support plates must again be used to prevent the bottom most wheels from collapsing together. This is the reason also for the inserted wedge opposite the top rod. This wedge prevents collapse of the top crank wheels. Be sure to tap the wedge into position before attempting any pressing.



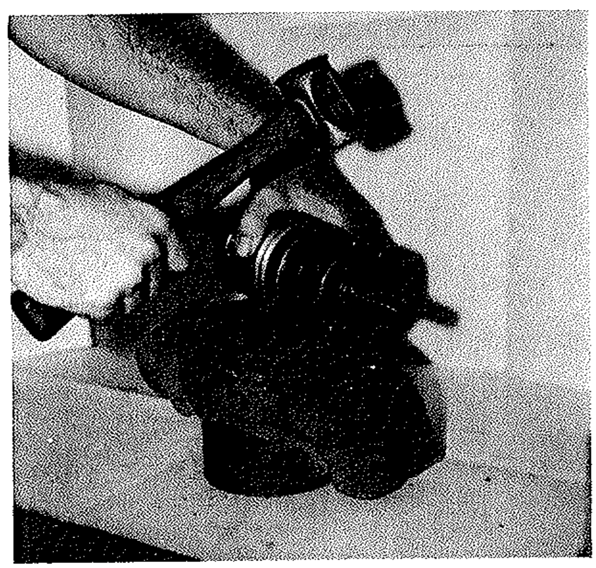


17...The completely reassembled crankshaft is pictured here. Use a vernier caliper to check wheel width of the entire assembly. The crankshafts are designed with shouldered center splines to stop the crank halves from being pressed too close together, but it is possible for a tight spline fit to temporarily prevent the crank halves from sliding completely together.

ALIGNMENT

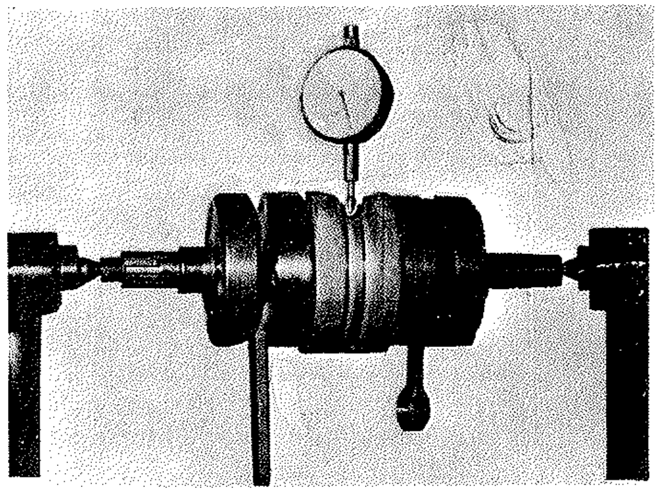


Hold the assembled crankshaft between two centers and check for run-out (all tolerances are listed in the SERVICE DATA section).



To change the crankshaft assembly alignment, strike the shaft a glancing blow with a soft hammer while supporting the crank assembly.

A final run out check should be made by placing the dial indicator against the middle of the center block. Hold the center block to prevent it from turning and then rotate the crankshaft. 'Run out' must be less than .02mm on all models.



REPLACING CENTER BLOCK BEARINGS AND SEAL

As to the necessity for rebuilding a center block, just remember that these components are the most difficult parts in the entire engine to replace. If the crankshaft has been damaged to the extent that major crankshaft servicing (splitting the crank) is necessary, then it should be standard procedure to also replace the center seal and two center main bearings. Customer cost is small, the rebuild time is short, and you will have 'job insurance' against premature part failure.

Special consideration should be given to the method used when dismantling and rebuilding the center block (on models that have center blocks). To prevent unnecessary damage to the various components, the steps listed below should be strictly adhered to.

Assume that the crank halves have been split and the center block has been pressed off. The center block contains two bearings, a circlip and a labyrinth seal. Begin disassembly by:

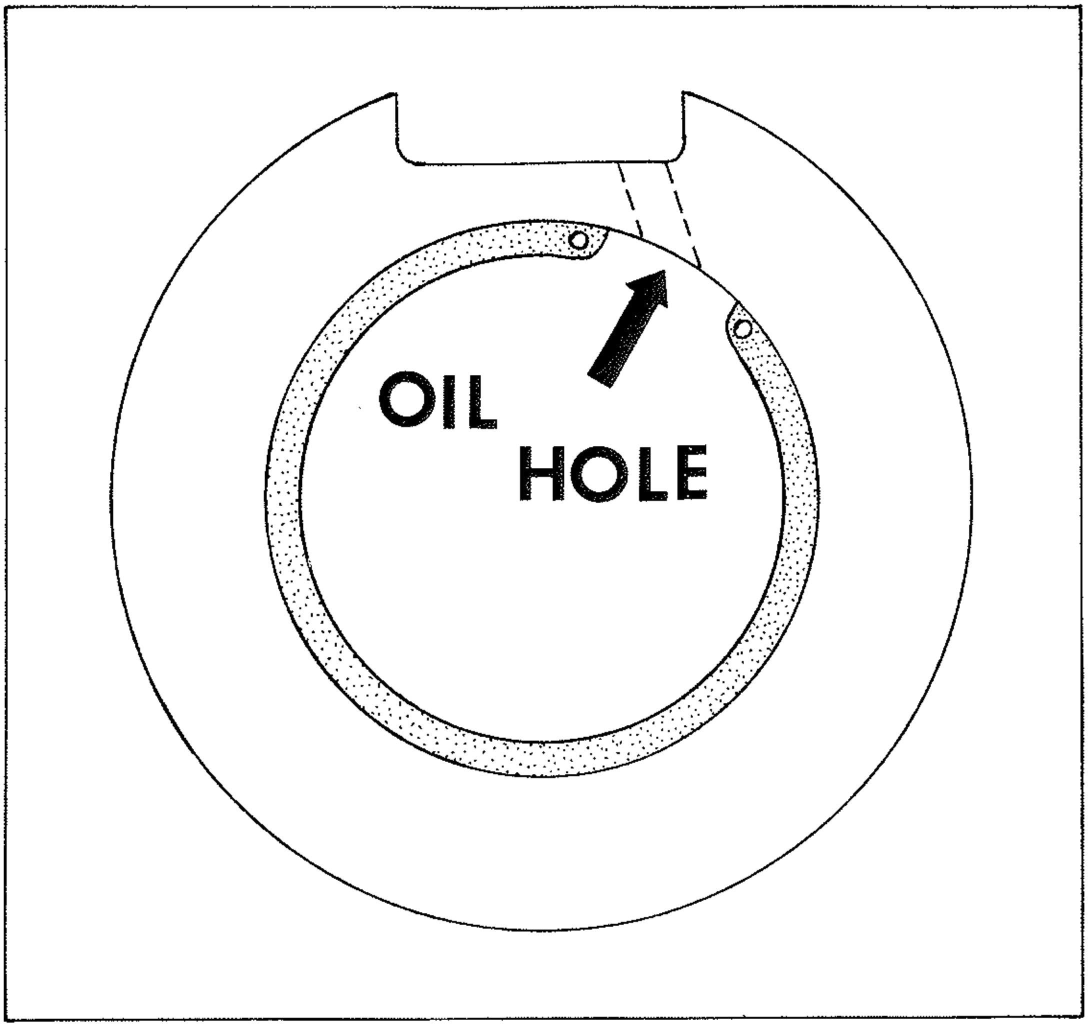
1. Placing the center block on parallel supports (such as the crankshaft jig) and use a drift pin to tap out first one bearing, then flip the center block over and tap out the other bearing.

2. Remove the steel circlip.

3. Still supporting the center block on parallel surfaces, use your press to push the labyrinth seal straight down and out of the center block.

The following steps are highly recommended to insure installation without damaging any parts, especially the aluminum labyrinth seal.

1. Reinstall the circlip. The gap in the circlip <u>must</u> straddle the oil hole.

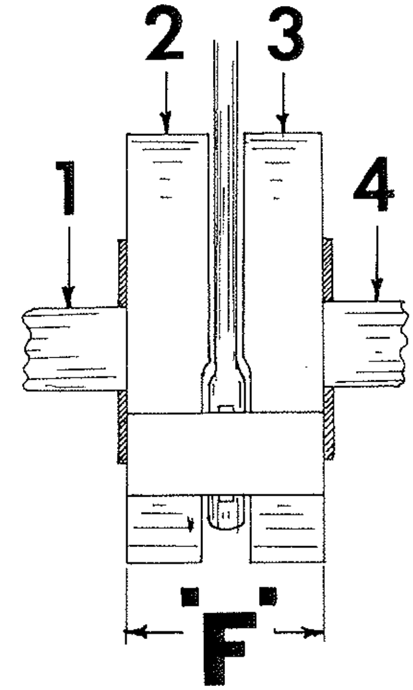


2. Install the new labyrinth seal: in preparation to install the seal, it is essential that the center block be heated. Also, it is recommended that you freeze the seal (such as in a freezer) if the facilities are available. These two preparations will serve to expand the center block and shrink the seal. The total effect allows the labyrinth seal to drop into the center block with little or no resistance. Butt it up against the circlip.

3. Insert both bearings into the still-warm center block. Because of the expanded block, they should also slip in quite easily.

The rebuilt center block is now ready to be fitted onto the crankshaft.

SINGLE CYLINDER

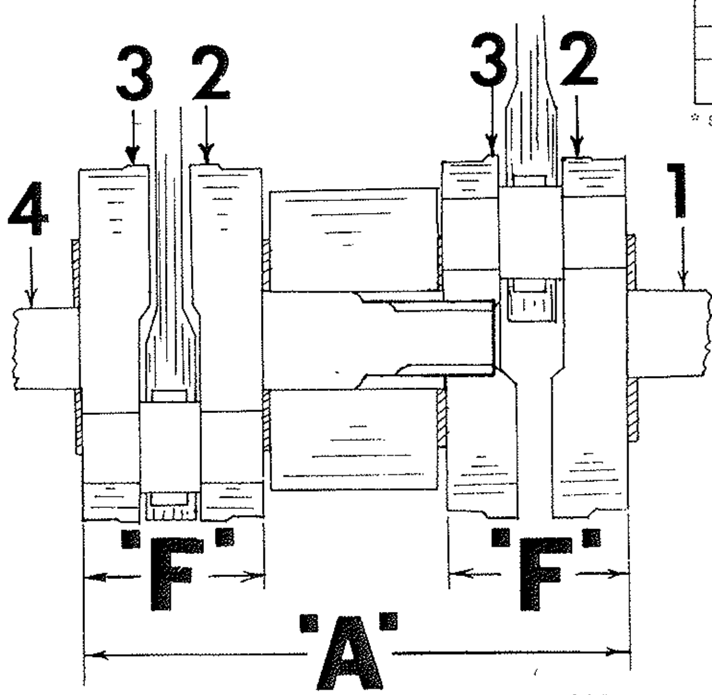


ALL DIMENSIONS GIVEN IN MILLIMETERS

ENGINE	DEFLECTION TOLERANCE		FLYWHEEL WIDTHS	
	1 & 4	2 & 3	F	A
U5(& E)	.02	.06	43 + .00 - .10	
MJ2	.02	.06	38	
YJ(1 & 2)	.03	.06	43 + .00 - .10	
G1	.02	.06	43	
GS1T	.02	.06	43 + .00 - .10	
G5T	.02	.06	45 + .00 - .10	
G5S	.02	.06	45 + .05 - .10	
L1(& E)	.02	.05	43 + .00 - .10	126 + .00 - .20
L2(& C)	.02	.05	50 + .00 - .10	
L5T	.03	.06	50 + .05 - .10	
A5	.02	.06	50 + .00 - .10	
A6	.02	.06	50 + .00 - .10	
AT1	.03	.06	56 + .05 - .10	
AS1(& C)	.02	.06	43 + .05 - .10	126 + .10 - .20
AS2C	.02	.05	43 + .05 - .10	126 + .10 - .20
CS1(& C)	.02	.06	47 + .05 - .10	140 + .10 - .20
CT1	.03	.06	56 + .05 - .10	
DS1	.02	.06	50 + .05 - .10	145 + .10 - .20
DS2	.02	.06	50 + .05 - .10	145 + .10 - .20
DS3(& C)	.02	.06	52 + .05 - .05	151 + .10 - .10
DS5	.02	.06	52 + .05 - .05	151 + .10 - .10
DS6C	.02	.06	52 + .05 - .05	151 + .10 - .10
DT1(A & B)	.02	.06	62 + .00 - .05	
M1	.02	.06	52 + .05 - .05	151 + .10 - .10
M2(& C)	.02	.06	52 + .05 - .05	151 + .10 - .10
R1	.015	.05	55.75 *56.00	163.5 *164.0
R2(& C)	.015	.05	55.75 *56.00	163.5 *164.0
R3(& C)	.015	.05	55.75 + .05 - .05	163.5 + .10 - .10

* Specifications of early R1 and R2 models, Engine No. 4794 and below.

TWIN CYLINDER



YAMAHA

MECHANICAL MEASURING DEVICES

MECHANICAL MEASURING DEVICES

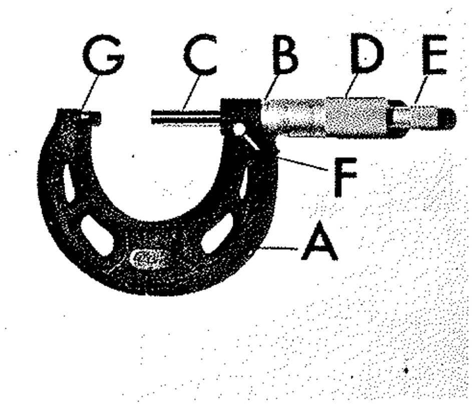
MECHANICAL MEASURING DEVICES

There are four types of measuring devices normally used when repairing Yamaha motorcycles.

1. Outside diameter micrometer
2. Vernier caliper
3. Dial indicator
4. Cylinder gauge (inside diameter micrometer)

I. OUTSIDE DIAMETER MICROMETER

The micrometer spindle (C) moves in and out as the ratchet is turned--one revolution giving an axial movement of .5mm. Also, since the spindle screw moves in a fixed nut, the turning of the spindle and the axial movement are proportioned.

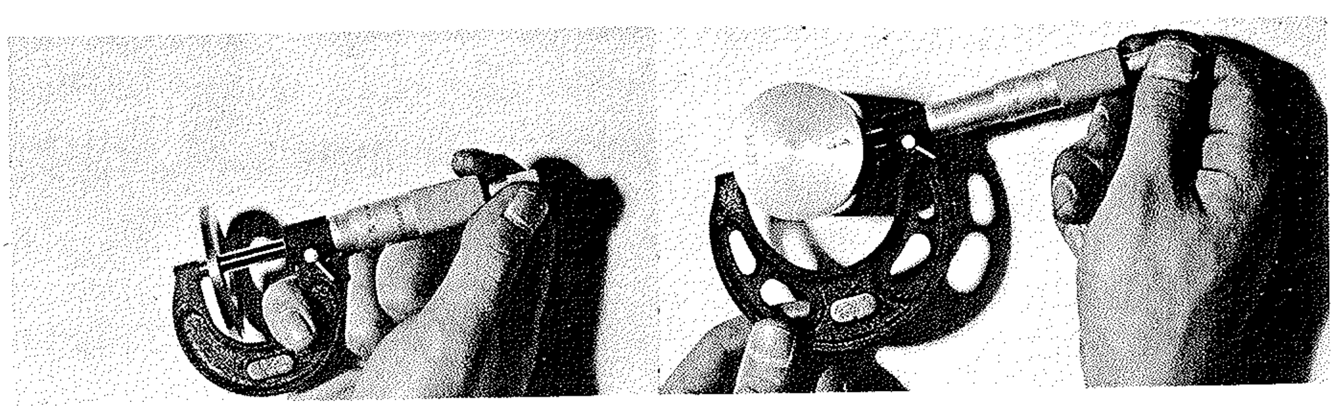


A. Frame or base
B. Sleeve
C. Spindle or rod
D. Thimble
E. Ratchet
F. Clamp
G. Anvil (or fixed end)

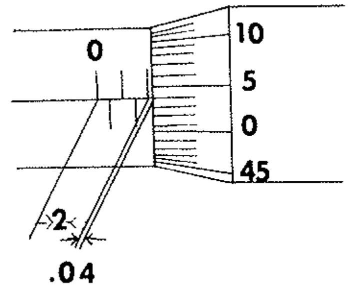
The thimble is fixed on the spindle and indicates the percentage of revolution, while the sleeve counts the total revolutions. The scale on the thimble is divided into 50 equal parts, thus one graduation is 1/50 of the .5mm distance of travel per complete revolution, or .01mm. Total measurement is obtained by reading the scale on the sleeve and adding it to the reading on the thimble.

How to use the micrometer

The micrometer is used to measure diameters, widths, lengths, and thicknesses. The object to be measured is placed between the anvil and the spindle. Hold the micrometer evenly and turn the ratchet slowly in a clockwise direction until two or three clicking sounds are heard, then read the scale.



(a) Twist the ratchet until the anvil and spindle firmly contact both sides of the object to be measured. Then look to the sleeve and count the amount of dash marks (each one equals .5mm) that are visible. Multiply the amount of marks by .5mm.



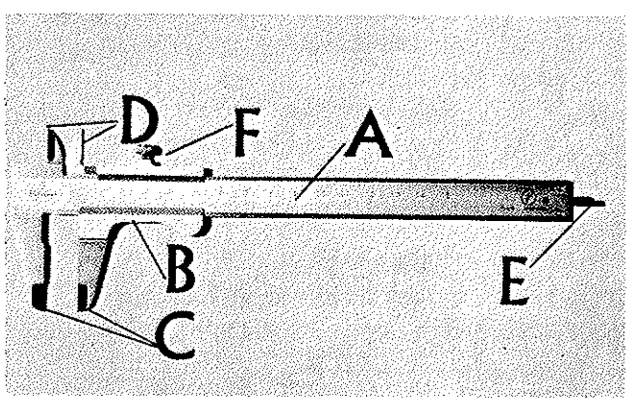
$$\begin{array}{r} 2 \\ + \ 0.04 \\ \hline 2.04\text{mm} \end{array}$$

(b) Next, look at the scale on the thimble and note the thimble mark that lines up with the sleeve centerline. Now count how many marks past the '0' on the thimble scale the 'lined up' mark is. Each mark equals .01mm, so multiply the amount of the marks by that figure.

(c) Add together the millimeters added up from step 1 (marks visible on the sleeve) and the total fraction of the millimeter calculated in step 2 (marks past '0' on the thimble). The total of the two calculations is your final measurement.

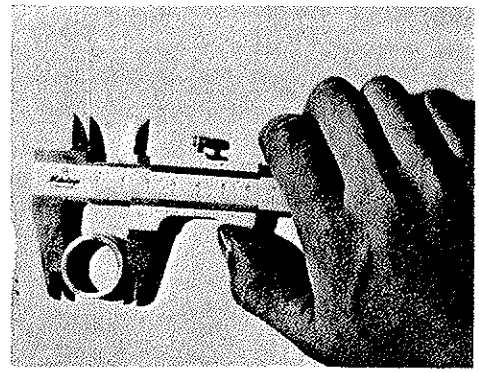
II. VERNIER CALIPER (METRIC)

The vernier caliper used by Yamaha can be used to measure width, thickness, outside and inside diameters, and depth. The main scale is in 1mm units, and the vernier scale measures in units of 1/20 (.05mm).

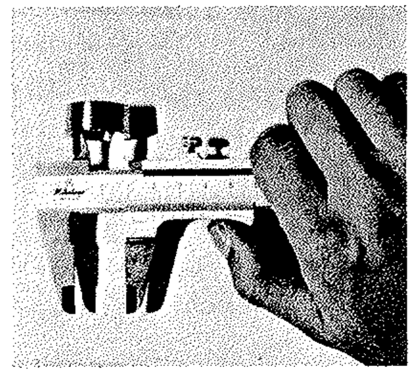


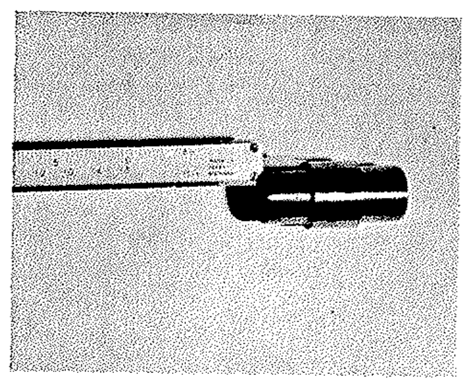
A. Main scale
B. Vernier
C. Jaws
D. Nibs
E. Rod
F. Lock

A. How to use the vernier caliper

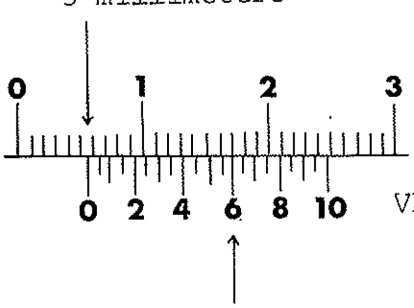


Assume that the vernier has been slid back, opening the jaws to any random distance. Now to read the amount that it has opened. You will note that the main scale is broken up into dash marks, each indicating one full millimeter. For easier reading, the main setting is numbered in centimeters (10 millimeters to each centimeter). Take note of the number '0' on the vernier scale. Count the amount of millimeters, from left to right on the main scale, until you come even with this '0'. This will give you the amount of whole millimeters. To determine the fraction of a millimeter, you must next take a reading off the vernier scale. Look at all twenty marks on the vernier scale and find the one that exactly lines up with a mark on the main scale. Only one mark will actually line up, though others may come close. Count the amount of marks on the vernier scale, again from left to right, until you reach the one mark that lines up. Multiply the amount of marks by .05mm. Add this total to the amount of millimeters that you read off the main scale, and this overall total will be the distance between the jaws (or nibs, if you are measuring an inside diameter).



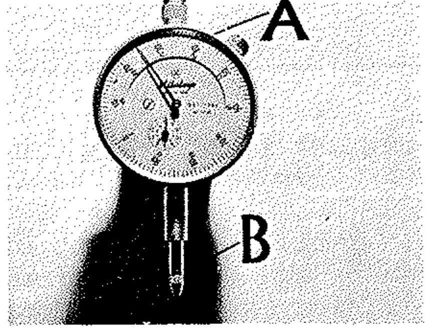


B. A sample reading



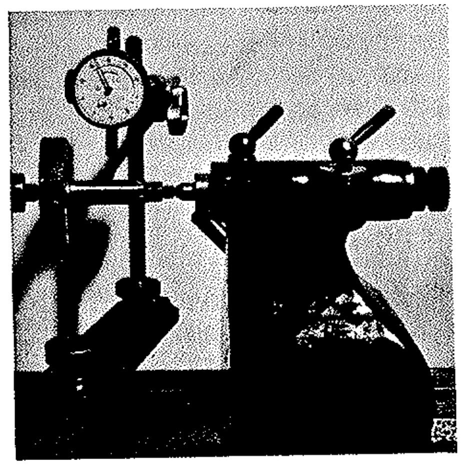
Main scale--- 5.++
Vernier scale--.60
Total 5.60mm

III. DIAL GAUGE (METRIC)



The dial gauge used by Yamaha registers in .01mm units. When the measuring rod (B) moves 1mm, the dial gauge needle will make one complete turn. The dial face (A) is divided into 100 equal divisions. Each line indicates .01mm.

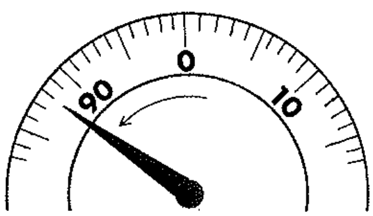
A. How to use the dial gauge to measure crankshaft run out.



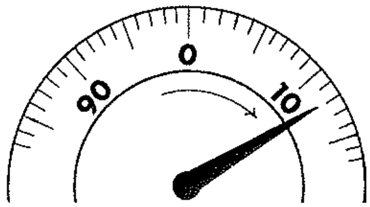
Set the dial gauge in the gauge holder, near the object. Set the tip of the gauge rod against the surface you wish to measure, and turn the dial face to line up the '0' with the needle. When turning or moving the object and the measuring rod moves up, the dial needle will move to the right (in a clockwise direction). When the rod drops down, the needle will move to the left (in a counter-clockwise direction).

B. A sample reading

-0.12 mm

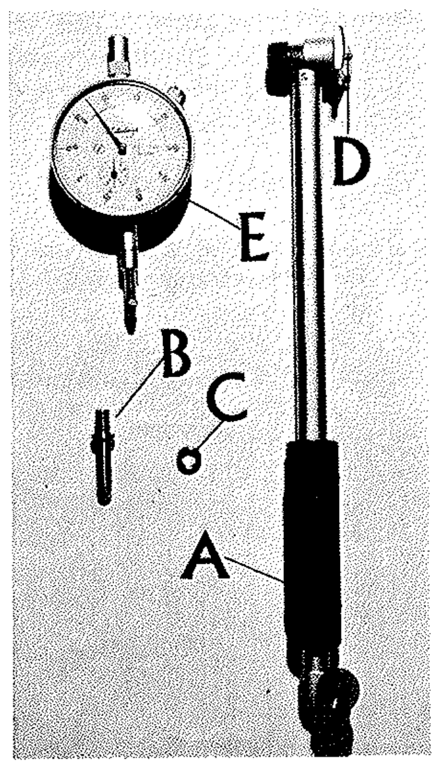


+0.12 mm



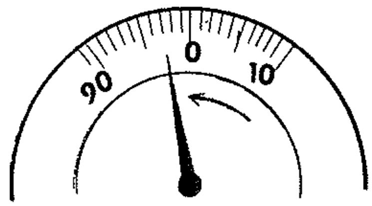
IV. CYLINDER GAUGE (METRIC)

The cylinder gauge used by Yamaha to measure the inside diameter of the cylinder has its dial face divided up into divisions of .01mm. This gauge has a measuring rod (D) and the movement of this rod is indicated on the dial.



A. Handle
B. Anvil (comes in several lengths)
C. Shim
D. Rod
E. Dial Gauge

4. If the needle stops before the '0' a total of .03mm, and the base setting was 54mm, then the actual size of the cylinder is 54.03mm.



0.03mm

NOTE:

1. Make sure the gauge is placed correctly in the micrometer, and in the cylinder. otherwise the measurements could possibly be incorrect.

2. Hold the cylinder gauge by its handle only.

3. Take two or three measurements to assure yourself that the dimensions along the entire length of the cylinder bore are equal.

YAMAHA

RACING

RACING

SECTION 1: RACING THEORY

This section will deal with the modifications of a Yamaha as a complete process, as it is necessary to relate several modifications together in order to obtain a large increase in engine performance. Merely raising the compression ratio, as an example, is not a complete and satisfactory engine modification. You will find explained a little further in this section several methods that are recommended if your desire is a "quick" machine.

A. The basic considerations for increased output of two-cycle engines are as follows:
   1. To draw as much air/fuel mixture (in weight) as possible into the crankcase per engine revolution.
   2. To transfer and retain as much air/fuel mixture (in weight) as possible into the combustion chamber per engine revolution.
   3. To compress the air/fuel mixture in the combustion chamber as highly as structural strength and fuel octane will allow.
   4. To ignite the compressed air/fuel mixture at the best location and timing.
   5. To convert the expanding gas pressure into engine torque as as efficiently as possible.
   6. To expel the exhaust gases as completely as possible from the combustion chamber per engine revolution.
   7. To reduce all possible mechanical and thermal loss.

B. The practical measures for tuning are considered to be the following within practicable limits:
   1. To increase compression ratio of the combustion chamber.
   2. To increase compression ratio of the crankcase.
   3. To change port timing of the exhaust port, intake port and transfer port for quicker breathing.
   4. To reduce gas flow resistance in exhaust, intake and transfer passages.
   5. To tune the exhaust passage.
   6. To reduce mechanical loss.
      a. To reduce frictional loss of oil seals, bearings and other sliding parts.
      b. To reduce oil viscosity loss in primary reduction gears, gear box gears, crankshaft web, clutch housing, etc.
      c. To reduce transmission loss in gears, chain, and sprockets.
   7. To select the best spark plug and its location.
   8. To select the best fuel and oil.
   9. To use proper cooling measures to prevent over-heating due to high output.

C. Measures for increasing output.
   1. Increasing compression ratios of the combustion chamber and crankcase.

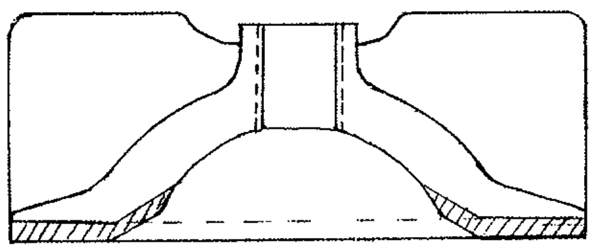
Basically, the purpose for increasing the compression ratio is to obtain an increase in torque. A mixture that is compressed into an altered combustion chamber of smaller size will exert more force during combustion. Compare it to a spring. The more you compress a spring, the stronger it will push back when released.

A general compression ratio rule is:

For street model.....................6 ~ 8:1
For scrambler or road racer...........8~10:1

When interpreting the compression ratios, be sure to understand that this is figured as the 'effective compression ratio.' This ratio is calculated by using the cylinder volume only until the exhaust port is opened. In order to obtain the effective compression ratio, you must first figure the volume of the cylinder just when the piston opens the exhaust port. Then figure the cylinder volume with the piston at top dead center. Comparison of the two volumes gives you the effective compression ratio. Many motorcycle manufacturers figure the compression ratio when the piston is all the way at bottom dead center. So, whatever cycle you plan to modify, first know what the actual compression ratio is to have a starting point.

The practical measure to increase combustion chamber ratio is to reduce the cylinder head volume by cutting off the flange and reshaping as shown below to the original squish angle.



Compression of the air/fuel mixture in the crankcase is done during the period from the closing of intake port to the opening of transfer ports. In ordinary street models, this compression stroke angle is 55~70 degrees. Naturally the crankcase compression ratio is an important factor of efficient scavenging. There has to be a sufficient pressure in the crankcase so that the mixture can be forced up the transfer ports and into the cylinder when the transfer ports open. When the cylinder compression ratio is raised, it is suggested (whenever possible) to raise the crankcase compression ratio to aid scavenging. This can be done in any of these methods:

a. Fill the balancing holes in the crankshaft webs with light materials such as aluminum alloy, cork, etc.

b. Fill all the unnecessary spaces in the crankcase with aluminum alloy.

2. Changing Port Timing
In high speed engines, exhaust, scavenging and intake processes have to be completed within a very short time, such as 0.001 - 0.003 seconds. Therefore, each port opening time has to be longer, which means that each port must open earlier. Also the area of the port and passage must be wider. Port timing is most commonly changed by (1) grinding material off the top and sides of the exhaust port, and (2) cutting a predetermined amount off the bottom of the piston. This opens the exhaust and intake port sooner than stock. The extent of modification will determine how much quicker, in degrees of crankshaft rotation, that the ports will open. Early opening of exhaust port results in decreased effective piston stroke, causing less torque in the lower engine speed ranges. Figure I shows the difference of port timing between the Yamaha YDS2 and TD1A. From this figure, we can see how early and how long the exhaust port opens in the racing engine. We can also study the other port timing. In tuning engines for speed, each port timing is modified from that of street model engine as follows:

(a) Exhaust Port timing.....Piston stroke opens the exhaust port 8% to 20% earlier than the street model.

(b) Transfer port timing....Piston stroke opens the transfer port 4% to 10% earlier than the street model.

(c) Intake port timing..... For piston-port types, intake port opening period can be increased up to around 30% more than for street model in crank angle. For the rotary disc valve model, the intake port opens up about 25% earlier than street model, and closes about 8-10% later in crank angle.

The above mentioned figures are just a target for tuning, so actually the port timing modification must be done by the "step by step" method.

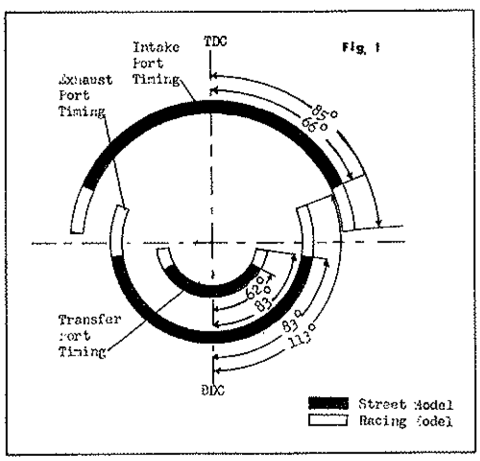
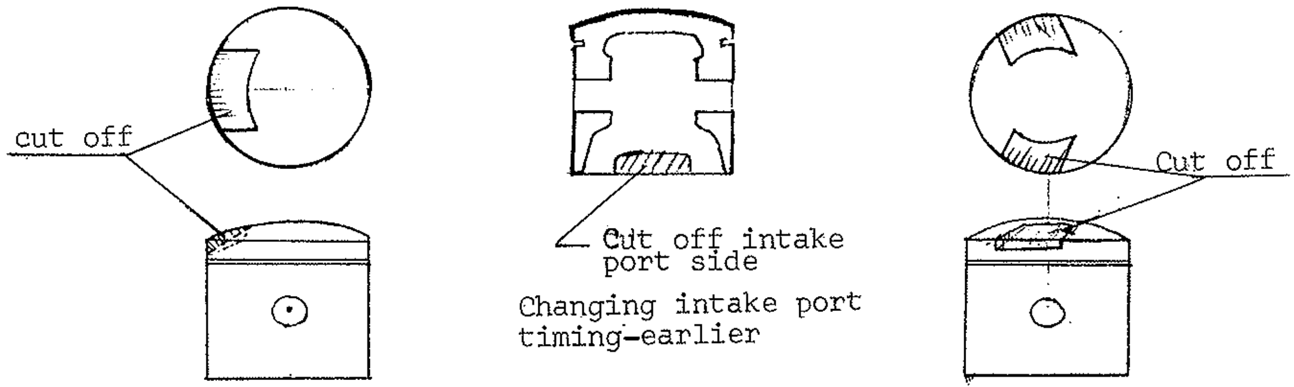


Fig. 1

Port timing can also be altered, other than changing the shape and height of the ports. This can be done by modifying the piston as follows:



Changing Exhaust Port timing-earlier

Changing intake port timing-earlier

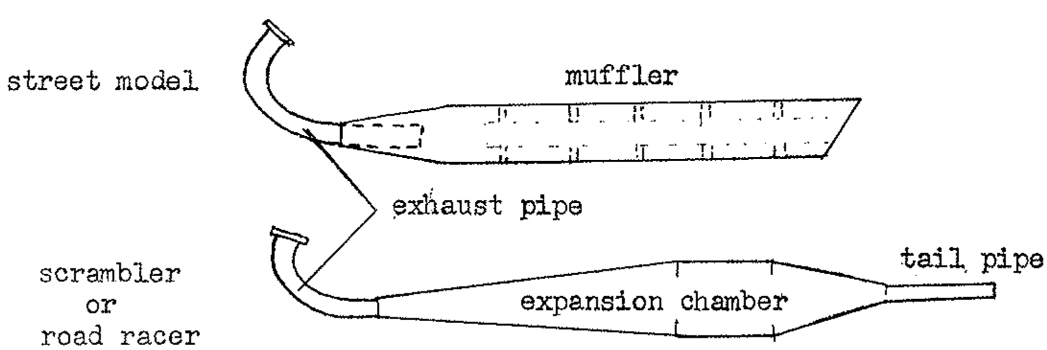
Changing transfer port timing-earlier

The maximum piston crown cut-off depth should be less than 2mm for fear of disturbing scavenging gas flow and because of thermal deformation and decreased strength of the piston.

Caution should be exercised, whenever the ports are modified, so that the shape and angle of the port is not changed. This is especially true of the transfer ports. These port angles are critical in that if they are altered, then the flow of the air/fuel mixture might not swirl through the chamber as it was designed. Overall intake and exhausting can be adversely affected.

3. Tuning Exhaust Passages

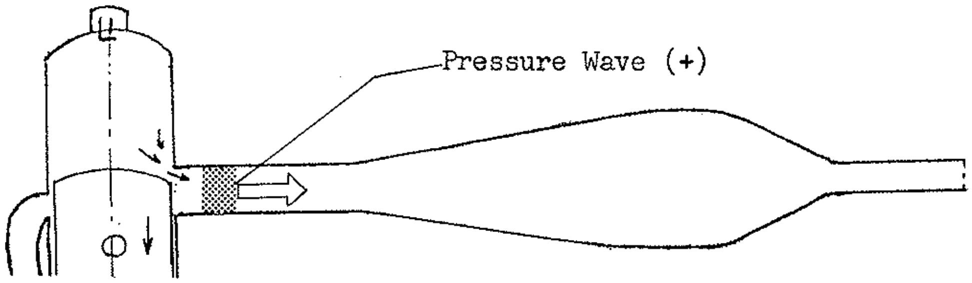
Generally the exhaust passage consists of the cylinder exhaust port, exhaust pipe, and muffler for the street model. However, for scramblers and road racers, the exhaust pipe and muffler consists of two parts: Expansion chamber, and tail pipe.



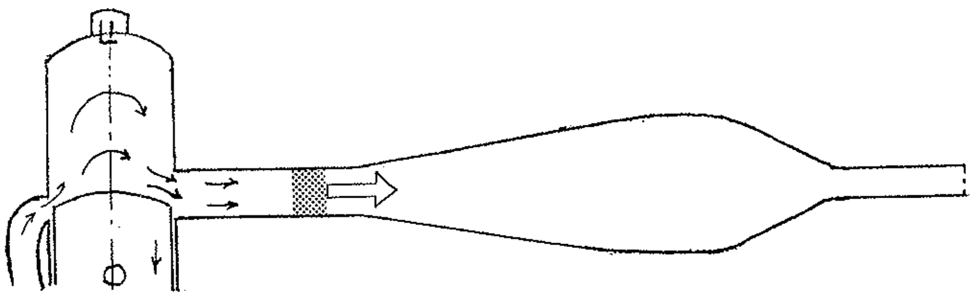
The expansion chamber is specially tuned to develop maximum horse-power at high engine RPM's. In tuning an expansion chamber to be used on a scrambler or road racer, various items such as port timing, combustion chamber and crankcase compression ratios, RPM range, piston displacement, etc., are used a factors to determine its size and shape.

Exhaust gas pulsation, or longitudinal vibration of the gas column, is utilized for generating high output at desired RPM's. A brief explanation about how pulsation or longitudinal vibration of exhaust gas is used for high out put is explained below. Do not confuse pulsation or pressure waves with the actual flow of gas. In a manner similar to the waves of the ocean, there may be travel and resultant effect of the waves themselves, while there is little or no actual horizontal movement or travel of the water.

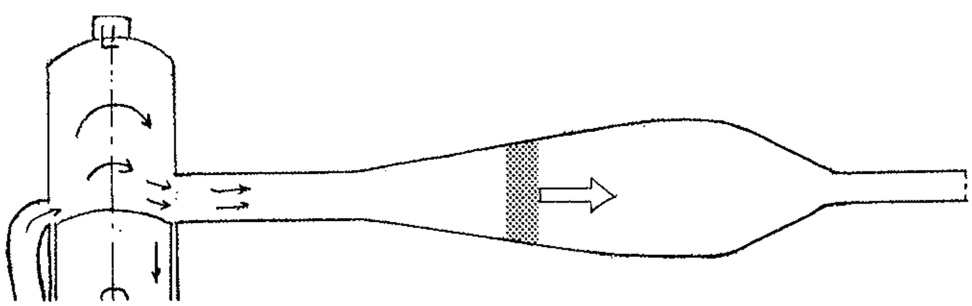
(a) When the exhaust port opens, a pressure wave is generated in the exhaust pipe by the high pressure gas flowing out of the combustion chamber.



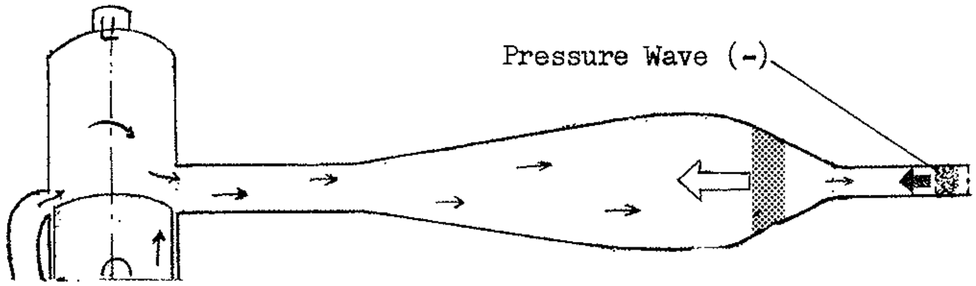
(b) This pressure wave travels through the exhaust pipe at a speed of approximately 1100 feet/sec. The high speed of this wave creates a low pressure area behind it which aids in drawing out the exhaust gasses.



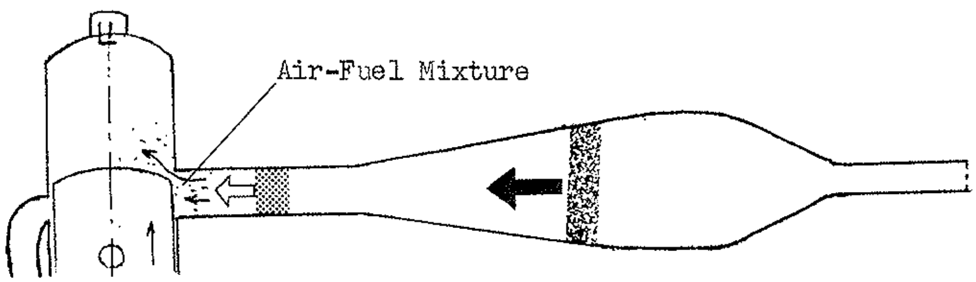
(c) As the pressure wave reaches the widening portion of the expansion chamber, it slows down and loses strength. The exhaust gasses following it also slow down but continue to move toward the end of the chamber.



(d) The pressure wave, when traveling through the narrowing part of the expansion chamber, gradually increases in intensity once again. Upon arriving at the narrowest part of the expansion chamber, it is partially reflected back toward the exhaust port of the cylinder. The remainder of the pressure wave continues out the tail pipe (stinger) where the exitting positive pressure wave creates a reverse phase (low pressure wave). The low pressure wave travels back toward the exhaust port.



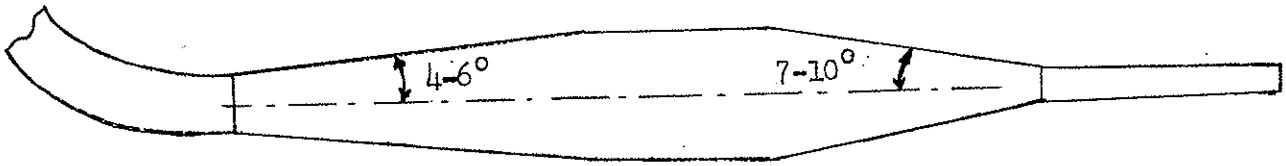
(e) The reflected positive pressure wave, if properly tuned, is directed back to the cylinder exhaust port. It partially prevents from escaping out the exhaust port the fresh air-fuel mixture that is being scavenged out of the combustion chamber. This reflected pressure wave holds the fresh charge in the combustion chamber in an attempt to increase the volumetric efficiency.



(f) The reflected low pressure wave, returning from the end of the tail pipe, arrives at the exhaust port of the cylinder some time behind the arrival of the positive wave. If the low pressure wave is timed to arrive a little before the next opening of the exhaust port, it generates a negative pressure in front of the exhaust port and assists in exhaust scavenging.

The narrowing rate (slope) of the expansion chamber must be greater than that of the widening part for the purpose of causing good reflection of the positive pressure wave. However, take note that too great a narrowing rate increases exhaust gas flow resistance.

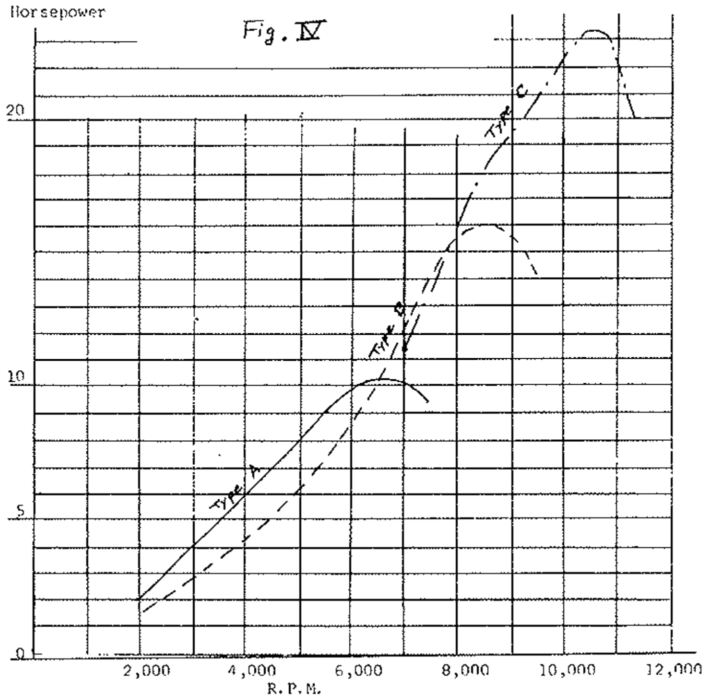
(g) The expansion chamber is usually shaped as follows:



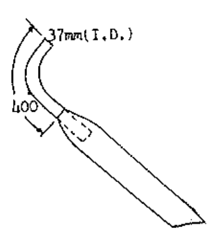
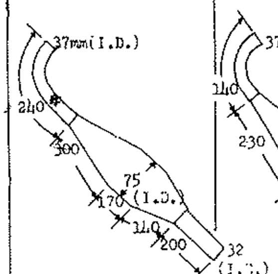
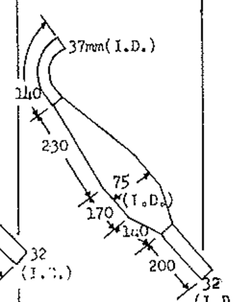
The inside diameter of the tail pipe, which is smaller for better reflection of the positive wave and for increased charging efficiency, should not be too small for fear of increasing exhaust gas resistance and thus decreasing exhaust and scavenging efficiencies. The ratio between the inside diameters of the tail pipe and exhaust pipe is usually 0.6 - 0.8:1. The length of the tail pipe determines the time difference between the plus pressure wave and the minus wave.

thing to be considered is that all the individual modifications are closely related with each other. A separate modification may sometimes have an adverse effect. The modification, therefore, should be done gradually and by the "step by step" method.

Fig. 1V shows horsepower curves of an experimental 125 cc engine, when it was tuned for the street, for scrambling, and for road racing.



Type A...for street running
Type B...for scrambling
Type C...for road racing. Cannot be used in the rpm range less than 7,000 because of instability.

TYPE	A (Street Model)	B (Scrambler)	C (Road-racer)
Cylinder port Volume (cc)	16.5	10.5	9.8
Cylinder port (from upper end)	Exh. 33mm Transf. 41mm	Exh. 29mm Transf. 39mm	Exh. 27mm Transf. 39mm
Piston	2mm width piston-ring---2	1mm width piston-ring--1 Piston crown exh. side--cut down 2mm	Same as left Same as left
Ignition timing	2.5mm B.T.D.C.	2.0mm B.T.D.C.	2.0mm B. T.D.C.
Intake rotary valve timing	Open...110° B.T.D.C. Close.. 39° A.T.D.C.	Open--130° B.T.D.C. Close--55° A.T.D.C.	Open-130° B.T.D.C. Close-60° A.T.D.C.
Carburetor	Main bore= 22mm MJ= #190	Main bore= 23mm MJ= #180--#200	Main bore=27mm MJ=#180-#200
Muffler or Expansion Chamber			

6. Gear Ratio Selection

In any form of competition the advantage of increased torque and/or horsepower is of little consequence if it is not used correctly. A most important consideration is the selection of the proper overall gear ratio with respect to the effective RPM range of the engine. Gear ratio determines the way in which the power of the engine will be used and the choosing of this ratio is equally important in all types of competition.

When determining the proper ratio, there are several factors to consider.

A. Type of race

B. Length of race

C. Type, length, and condition of track

D. Highest and lowest speed possible on track

E. Weather conditions

F. Amount of fuel carried

G. Altitude

Keep in mind that all the factors should be taken into consideration and the final gear ratio should be decided which will provide the fastest lap time under the prevailing conditions. It is not always the motorcycle with the highest speed potential that wins but the one that can get around the track in the shortest time.

Specifically, the "rule of thumb" is to hit peak engine RPM's just before the shut-off point in order to achieve minimum elapsed time for any given stretch. Following this, consideration must be given to the start or corners so that an effective RPM range is also available there. Individual experimentation is the only way of determining the best possible final ratio.

SECTION 2: STREET MODIFICATION (50% RACE TUNING)

Generally speaking, the engine will be modified to specialize, or specifically, to perform better at some one particular RPM range, in contrast to the standard street machine which has as broad a power band as possible. The strong effective RPM range is usually something like 3,000, but when an engine is modified for increased top end, lower end performance not only falls off, but usually the strong RPM range is also narrowed to about 2,000. When modifying for street purposes (which is the subject being discussed here) generally the desire is to strengthen it in the 6,000 to 8,000 range and hope to have as much as possible carry over into the 9,000 RPM range.

The greatest difficulty in doing this for street purposes is that the biggest power asset to the 2-stroke engine is a tuned exhaust system in the form of an expansion chamber, and of course this is illegal for street use. There are so-called street use expansion chamber mufflers on the market, but there has been no proof positive that these are really better than the standard Yamaha mufflers which are quite good.

Yamaha offers a GYT kit and it is very suitable as a total 'bolt-on performance' for racing purposes. However, as a factory, Yamaha does not recommend this much modification for street use because omitting the expansion chamber drastically cuts down the power output, and also the high RPM power band makes it impractical for the stop-and-go driving conditions. However, a stock street machine can be modified to perform far better by cautiously applying certain basic engine modifications. The rule of thumb is that for street modification, do not modify the engine more than 50% of the 'full treatment' (GYT specifications that would be done to a true racing machine).

Proper follow-through for the above is a necessity. What is meant by follow-through is analysis of such factors as spark plugs, carburetion, tires, sprocket ratio and the like. These are completely dependent upon riding habits, intended use, available fuels, and all the other individual matters that make this motorcycling sport so interesting. Keep the proper end product in mind and consider each case individually as to basic machine, rider needs, and budget.

All following steps should be treated as an all-inclusive total picture. All of the various working parts of the engine are closely related in their function and working relationship. A raised compression ratio affects exhaust and scavenging, and changes in scavenging affect and are effected by crankcase pressure. The crankcase pressure is of course closely related to intake porting. So consider the steps listed below and try them one by one.

1. INTAKE PORTING--In any engine, whether 2-stroke or 4-stroke, the object is to try to force in as much combustible mixture as possible. One

advantage of the Yamaha 2-stroke system is that it is not necessary to have to put out $75 for a new crankshaft to alter the port timing. If the Yamaha has a rotary valve, then the valve opening can be enlarged by grinding or filing away some of the material on the edge of the slot that opens the intake port. 'Full race' is approximately 20° different, so modify the standard one to about 5°to 8°, and definitely not more than 10°. If this particular engine has a piston-port system, then removing material from the bottom of the piston will open the port sooner. The full treatment is about 9mm and for street use 2 to 3mm is found to be about the best, with 4mm being the absolute maximum. When modifying any engine, always 'match' the intake port to the carburetor bore, enlarging slightly if you wish and always looking for bumps or irregular places that should be removed from the inside of this intake port.

2. EXHAUST PORTING--The exhaust port should open a little sooner, so the top of this port should be moved up a little higher in the cylinder and/or remove material from the top of the piston at the exhaust port (like the YDS3C used to be). A change of 2 to 3mm is about right, with 4mm being the absolute maximum. Here again, enlarge and smooth the inner surfaces of this exhaust port for best results.

3. COMPRESSION RATIO--Any time material is taken off the flat surface of the head, the hem of the combustion chamber should be reshaped to match the original chamfer. 1/ly of an inch off the face of the head is absolutely maximum, with .040 - .045" being just about right in most cases. Any more than this does not seem to help performance and it definitely does increase the heat problems, shorten spark plug life.

4. IGNITION SYSTEM--No change recommended here. The standard systems are quite satisfactory.

5. SPARK PLUG--If everything else comes out right, then the engine will probably need about a one-step colder spark plug. Careful readings are an absolute necessity and should be balanced with minute changes in carburetion which might be necessary to accommodate the changed breathing habits of this new engine.

6. INTAKE FILTER AND MUFFLER--Not much can be said or done here other than to state a reminder that these parts have now become increasingly critical and must be in the best possible condition. Don't run without an air filter, and try to see that the whole exhaust system is clean, including the inside of the outer shell of the muffler system.

7. FUEL AND TIMING--Gasoline condition becomes increasingly important and it has been found that there can be a big difference in fuels. The big problem is that the gasoline goes stale and about all that can be said is that if unusual deposits, or problems suddenly appear, try changing to a different brand. Timing may be advanced slightly, about .1mm earlier than this will put the engine on the ragged edge of possible failure and probably won't help anyway.

SECTION 3: GYT KIT
(Genuine Yamaha Tuning)

The GYT kit is a collection of bolt-on speed parts that the factory makes available to the public. These kits are not comprised of modified stock parts; they are separately manufactured by the factory. The purpose of a GYT kit is to eliminate the need for a "trial and error" method of tuning for power. The kits are designed to fit individual models, but not all Yamaha motorcycles have GYT kits. The contents of these kits varies from model to model, depending exclusively on the factory's judgement. However, there are some parts that are common to all the GYT kits that provide the basic method of gaining a power increase.

1. The factory cast GYT head has less capacity, increasing the compression ratio. It is also thicker and therefore stronger, and the spark plug hole is designed to take a racing plug.

2. The exhaust and transfer ports are widened and/or raised.

3. The cylinder is usually chrome-over-aluminum, rather than the standard cast iron lining.

4. The GYT kit runs with one ring. This ring, in conjunction with the chrome plated cylinder, requires very little break-in time.

5. The piston skirt length is several millimeters shorter than stock to alter duration of the intake phase.

6. The GYT kit furnishes an expansion chamber.

GYT kits vary in content from model to model. But in the past, points 1 through 6 (above) have been included consistently. The kit may also include several parts that have not been mentioned which are needed for a particular model or class of models:

1. For all-out racing, a magneto replaces the generator (on DC models).

2. Kits for rotary valve models usually include a stronger, more radically cut rotary valve.

3. Most times a larger size carburetor is included to take advantage of the improved breathing.

4. Gears, front fork parts, and other miscellaneous items are substituted if the factory considers it to be helpful.

If you have the time, patience, and desire to save money, it is possible for you to make your own head, cylinder, and piston changes. This bypasses the necessity of buying a GYT kit. On the following pages you will find that we have drawn illustrations and listed figures of different GYT kit changes.

Note--Sometimes it is better to not use the chromed cylinder and single ring, depending on the intended use of the GYT kitted Yamaha. A chromed GYT kit cylinder cannot be rebored. If it becomes scored, it has to be replaced. The standard cylinder, however, with its cast iron sleeve, can be rebored several times. Also there are times that the single ring might not be used. Some racers prefer to have two rings instead of one to act as insurance in case one of the rings should stick or break. Those riders that run in the rough events--short track, dirt, desert, enduros, scrambles, --are the ones that usually prefer the two ring set up.

Note--Whether you buy the GYT kit, or modify your own engine to match the GYT specifications, always remember that carburetion has to match the increased demand for fuel and air. You should experiment, if at all possible, to determine the largest size carburetor that you can use satisfactorily.

Note--Yamaha motorcycles that are running GYT kits do not function very well as street machines. The high amount of rpm necessary to develop the horsepower advantage from a GYT Yamaha cannot be reached under normal street riding conditions. Also the expansion chamber, essential to GYT kit performance, can never be used on the street as it is very much illegal because of the noise.

Note--The total GYT kit head volume is considerably less than stock. We highly recommend that you do not mill your stock head more than 1/16" in an attempt to match the GYT head volume because in many cases this would require taking off 1/8" or more. The stock head does not have the structural strength to withstand this much milling and the head could very possibly warp or crack.

Note--The Yamaha Warranty Program is voided if the machine is modified in any way. All modification is the total responsibility of the customer in regard to specific part, total machine, and/or end result of performance.

It is the desire and intention of the Yamaha Factory that the treatment of each model be regarded as a complete, balanced unit. Tests have shown that the given recommendations are most effective ONLY when ALL modifications and/or GYT replacements are performed. The total results are what count, and these results are a balanced end product of all the many complicated individual processes that go on inside of an operating engine. Changes, if performed individually, may have little, if any effect and have even been known to have an adverse effect. We suggest, therefore, that for ultimate satisfaction, the GYT procedure be followed through completely.

It should be understood that this information is offered strictly as a service to Yamaha racing enthusiasts. Yamaha International Corporation specifically makes no recommendations as to its application whatsoever, nor should such be implied. Furthermore, Yamaha International Corporation assumes no warranty or liability for engine performance, endurance, failure, destruction or any other condition, in part or in whole, as a result of any individual or group following the listed procedures.

REGARDING THE INFORMATION ON THE FOLLOWING PAGES

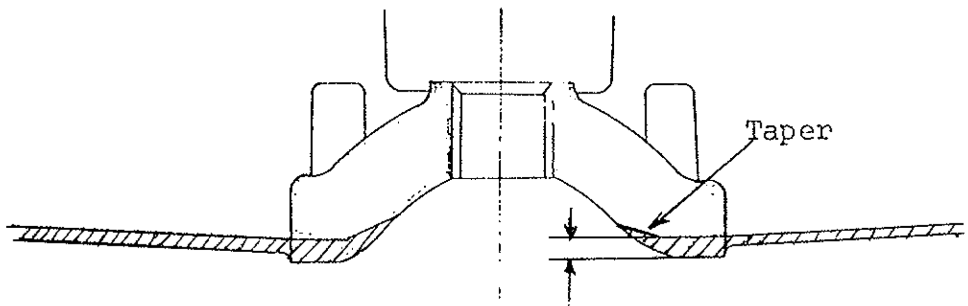
The information on the following pages was chosen to represent each major engine design. Detailed specifications are included for the most popular models within each of those particular designs.

Genuine Yamaha Tuning kits are available for most of the following models. Detailed information is included, however, in the event certain parts are not available from Yamaha International or for those individuals who wish to modify the existing parts on the machine.

It should be noted that use of GYT Kit parts is the best procedure for modification as these parts have been designed specifically for modified engines. For example: GYT heads, even though they have less displacement than stock, are reinforced to withstand higher compression ratios. In addition, great care has been taken to ensure spark plug placement is correct. Severe modification of a stock head may weaken its structure and, in addition, place the spark plug too close to the crown of the piston.

Cylinder Head:

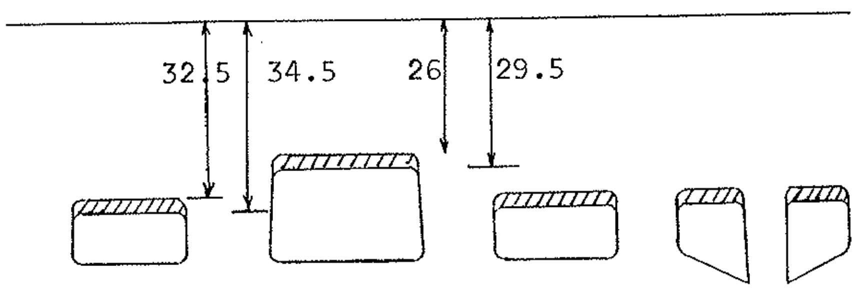
Mill the bottom of the cylinder head by 2 mm, maximum, and reshape the hem of the combustion and cooling fins as shown below.



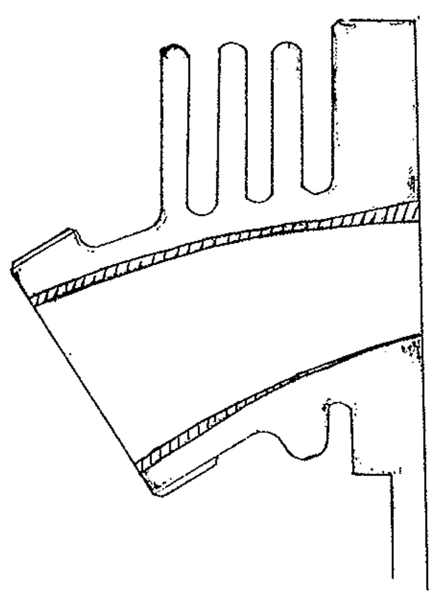
The sparkplug should be a B-8HN or a B-9HN.

Cylinder:

Grind the exhaust port and transfer ports at their upper edges in order to change the port timing (see the dimensions below).

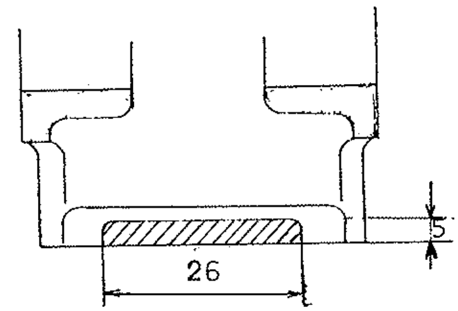


Grind the exhaust port to expand the exhaust gas passage as shown below.



Piston:

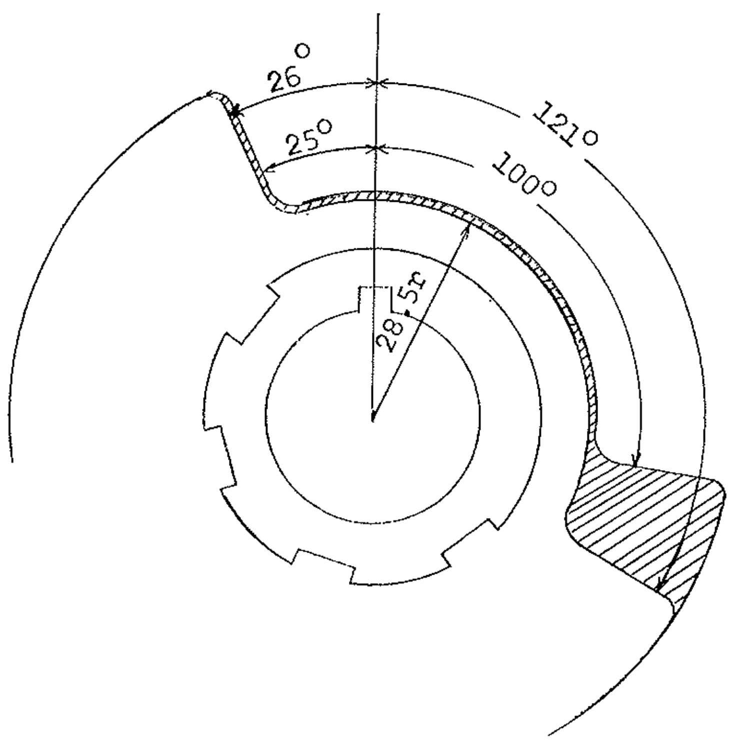
Cut away the piston skirt contacting the third transfer port (opposite the exhaust) as shown in the figure below.



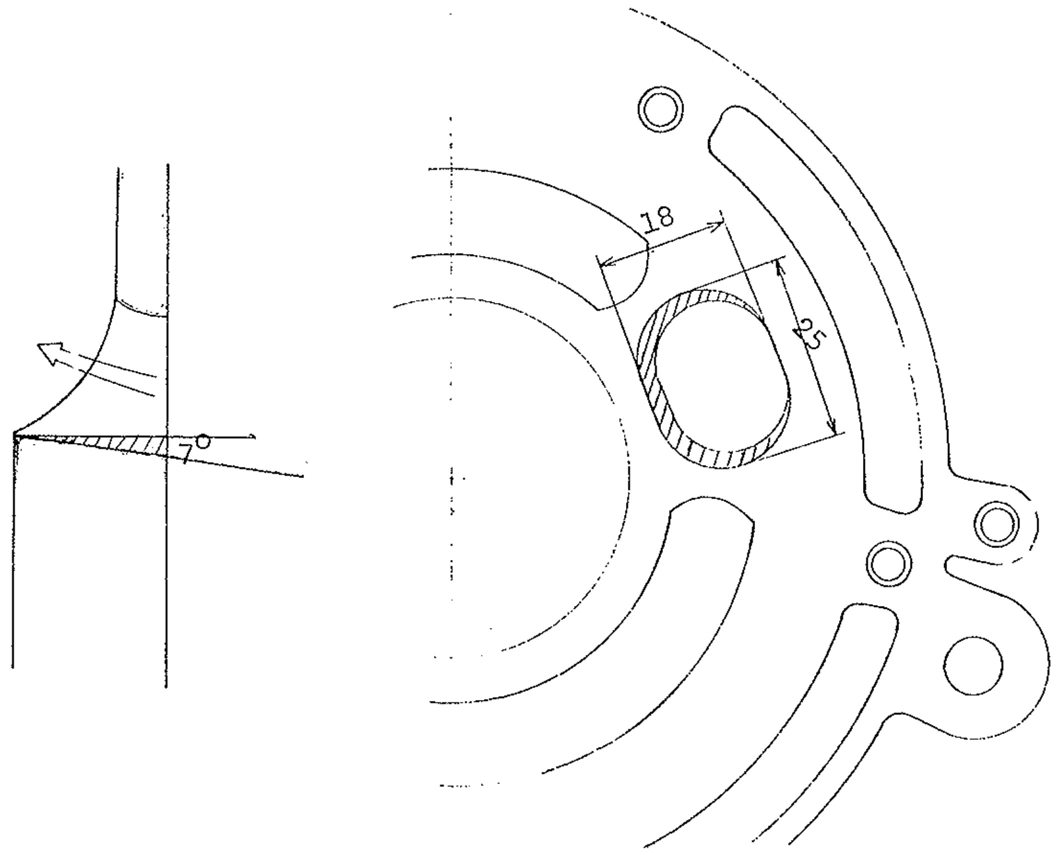
Rotary Valve:

Cut off and reshape the standard valve to increase the intake port opening period (see below). When doing this modification, the new 4-notch type valve should be used. Keep in mind that the modification process may decrease the strength of the finished part, and the choice of the GYT valve is recommended.

Intake port timing: modified and GYT (piston travel from TDC).
Intake port opens.....36.0 mm before TDC
Intake port closes....10.7 mm after TDC



Crankcase:
Reshape the intake port of the right crankcase so it matches the intake port of the valve cover (see the illustration).



The intake passage, which consists of the main bore of the carburetor, valve cover, valve, and right crankcase, should be smoothly connected without any steps.

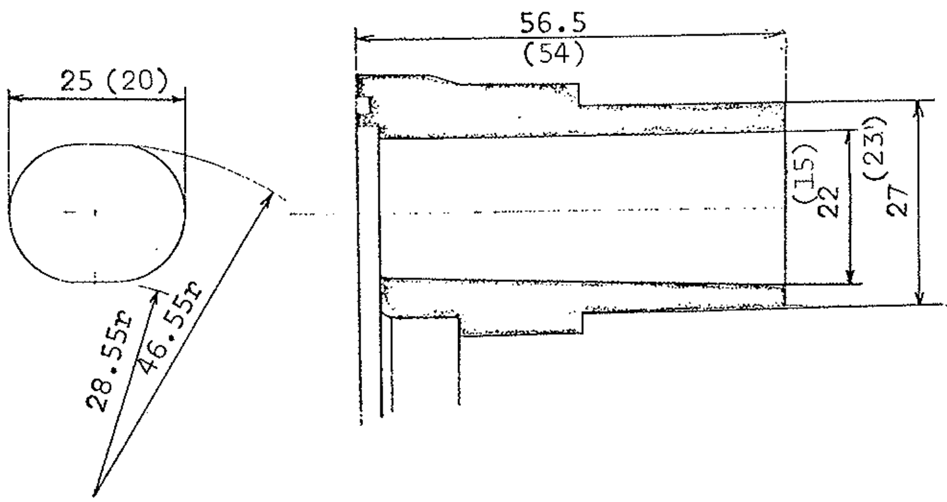
Right Crankcase Cover:
With the carburetor and valve cover change, the GYT right crankcase cover has to be used.

Carburetor Chamber Cover:
The special GYT cover (with gasket) must be used.

Valve Cover:

In order to use the bigger carburetor, the GYT valve cover must be used. The standard cover cannot be modified to work properly. Also the valve cover o-ring "B" for the YA-6 should be used with this substitution. Standard dimensions are enclosed in parenthesis and follow behind the GYT specifications.

The illustration below shows the differences in dimensions between the stock and the GYT valve cover.



Carburetor:

Use the MIKUNI VM22SC carburetor instead of the stock MIKUNI VM15SC carburetor. Main setting figures of this carburetor are as follows:

Main jet.....#260 (main jet range from #250 to #280)
Jet needle...#22 M-3 stage
Cut away.....#2.5

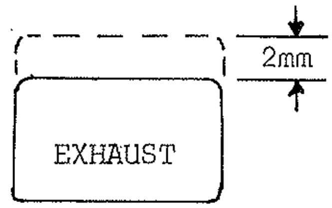
Expansion chamber:

An expansion chamber is a very necessary part that is included in the GYT kit.

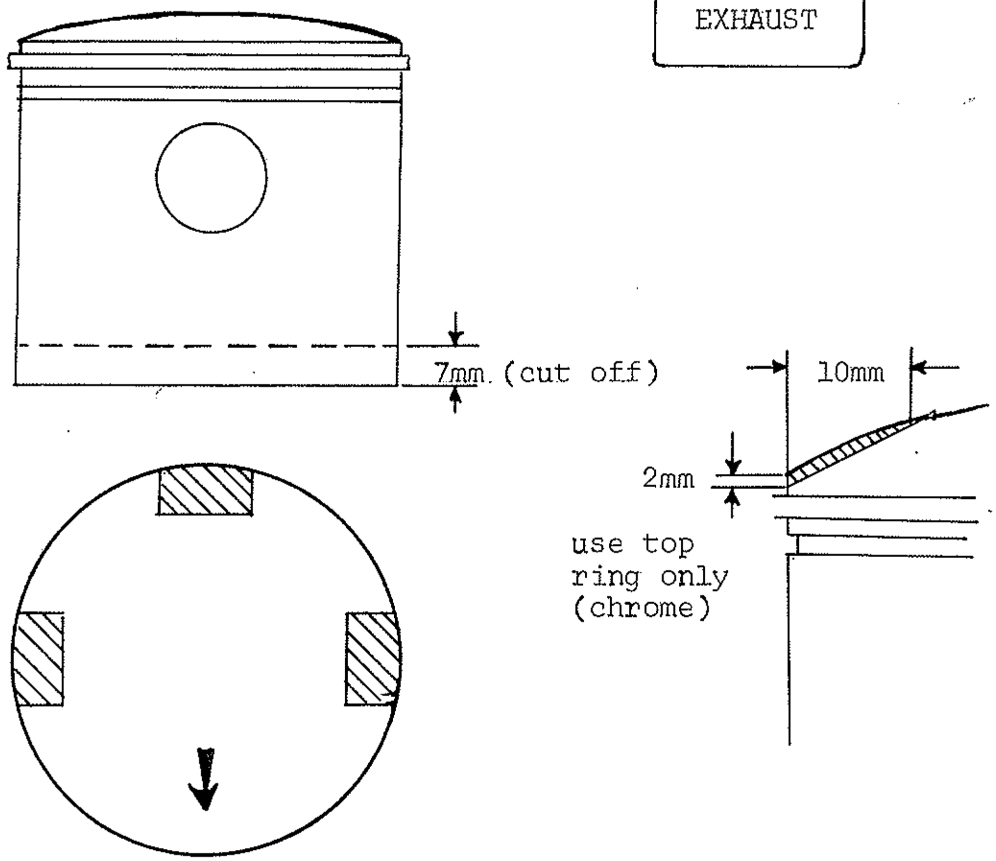
Cylinder Head:

Do not remove any material from the bottom of the head. The YL-2 head is "high compression" already. Also, a milled head drops the spark plug too close to the piston.

Cylinder: Raise the exhaust port 2 mm.



Piston:



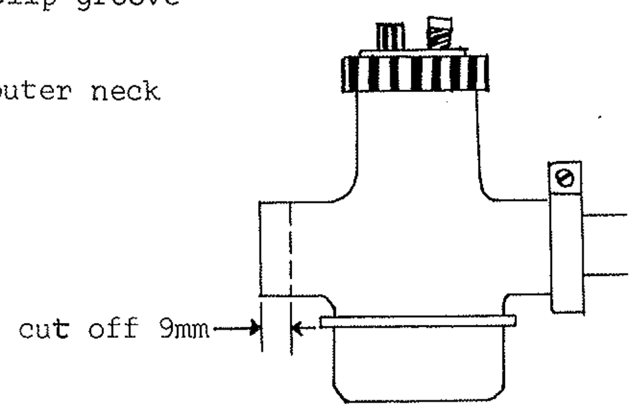
Carburetor:

Use the MIKUNI VM22SC Carburetor (YA-6).

Main setting figures are as follows:

Main jet.....#160 (without the carburetor cover=#240)
Jet needle...4J6--#2 clip groove
Needle jet...0-0

Cut off 9mm from the outer neck to allow better breathing.



Valve Cover:
In order to use the bigger carburetor, the GYT valve cover must be used.

Crankcase:
Reshape the intake port of the right crankcase so it matches the intake port of the valve cover.

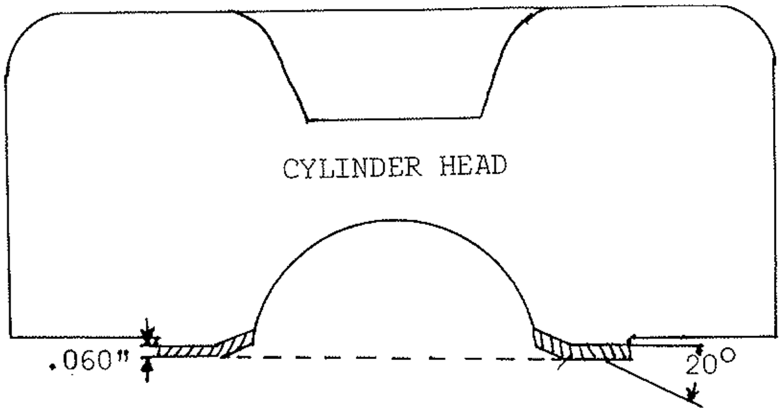
Right Crankcase Cover:
With the carburetor and valve cover change, the GYT right crankcase cover has to be used.

Carburetor Chamber Cover:
The GYT cover (with gasket) must be used.

Rotary Valve:
No new valve was included in the GYT kit because the standard part proved to perform quite satisfactorily.

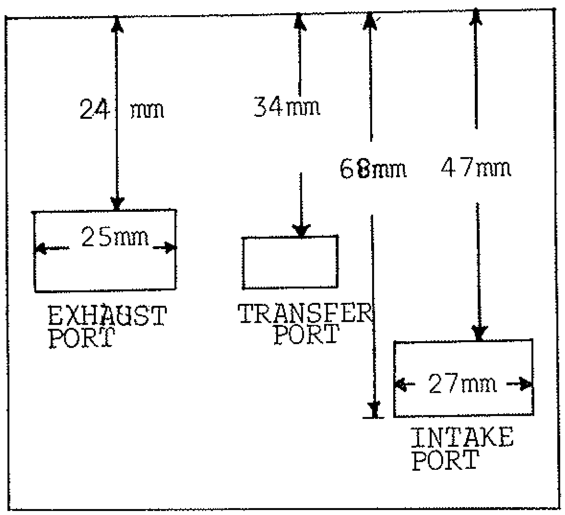
Expansion Chamber:
As is standard practice, the L2(C) GYT kit does include an expansion chamber.

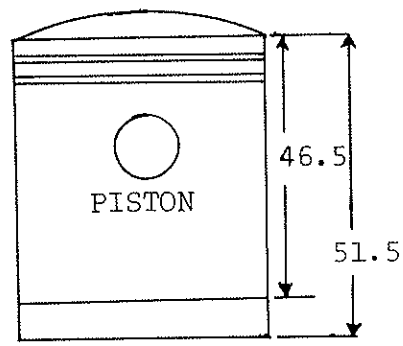
Machine .060" from the bottom of the head, then machine the 20% taper back in around the edge of the combustion chamber. See the drawing below.



Cylinder:

Change the port timing to correspond with the drawing below. Any dimensions not shown are standard.



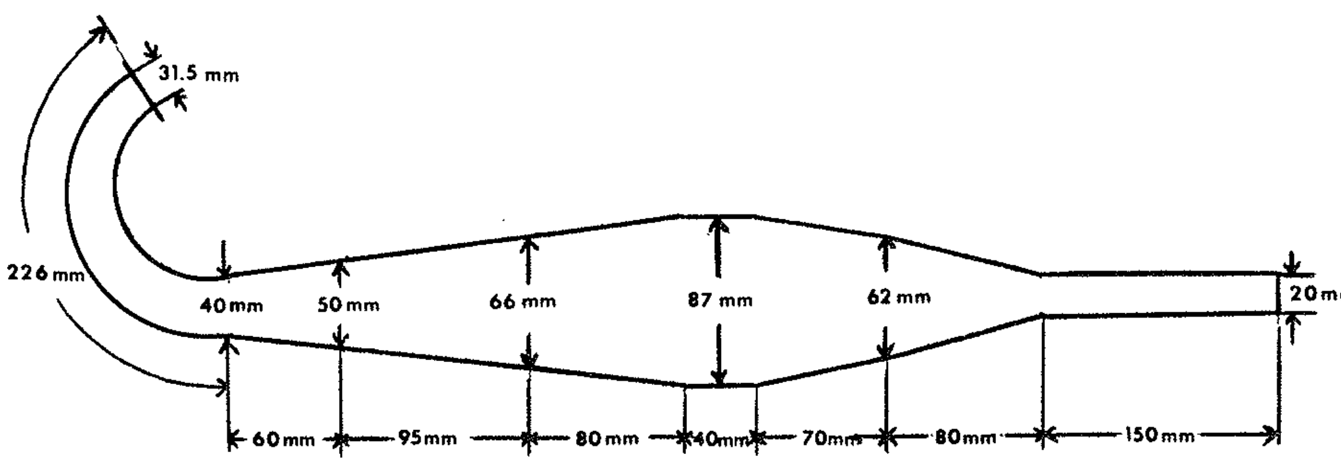


Piston:

Cut 5 mm from the bottom of the piston skirt all the way around, as shown. Use the top ring only. Sand any suspected seizure high spots from the piston after approximately five miles of running; repeat as necessary.

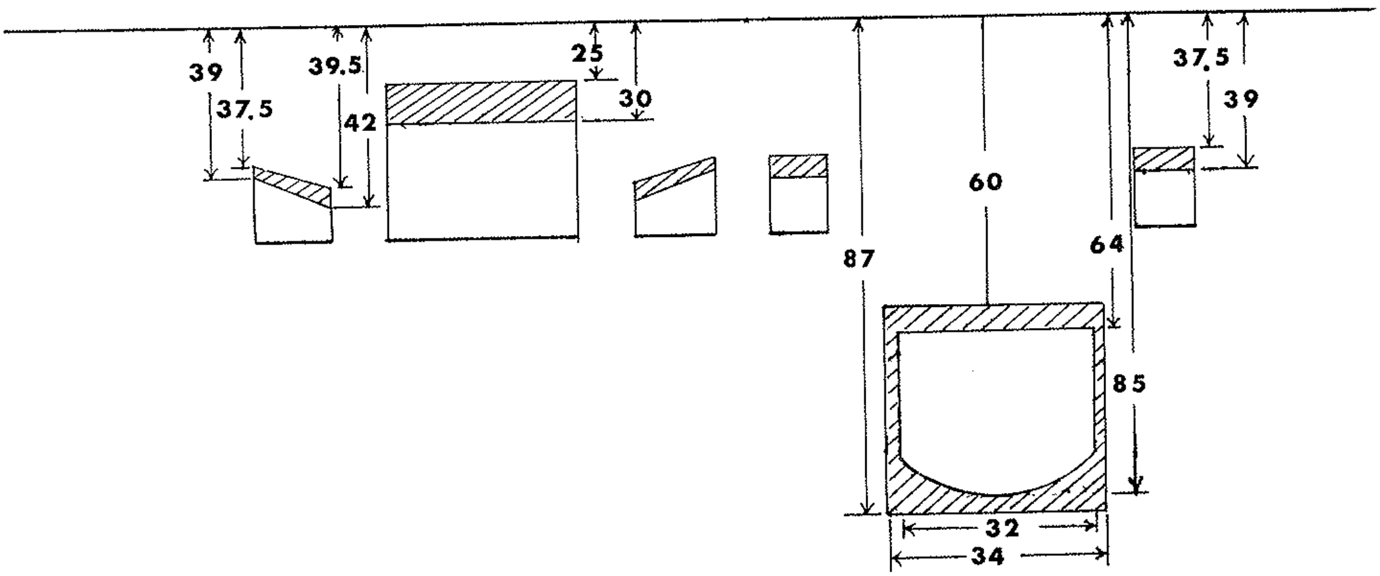
Expansion Chamber:

The specifications listed below were taken off the expansion chamber used for high RPM road racing.



Cylinder:

The shaded portions show the amount of material removal necessary to modify a DS-6 to match the porting specifications of the TD2 Daytona racer. (All dimensions are in millimeters).



Piston:

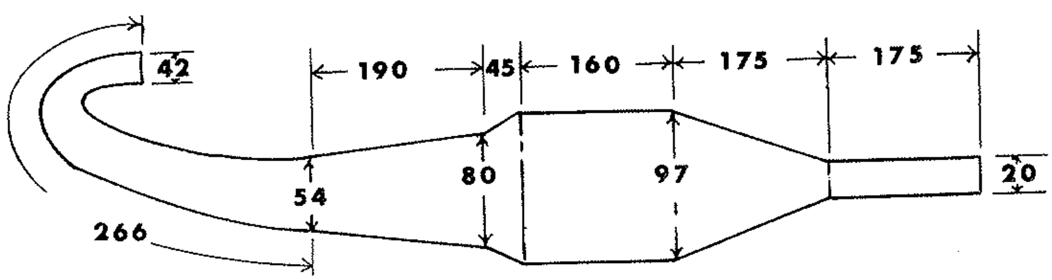
Standard piston is 63mm in length; the TD2 piston is 54mm long.

Cylinder Head:

The DS-6 head must be machined until it matches the 11.3cc TD2 head displacement. Be sure to remachine the taper back into the hem of the combustion chamber.

Expansion Chamber:

The dimensions given below (in millimeters) are those taken directly off the TD2 Daytona racer.

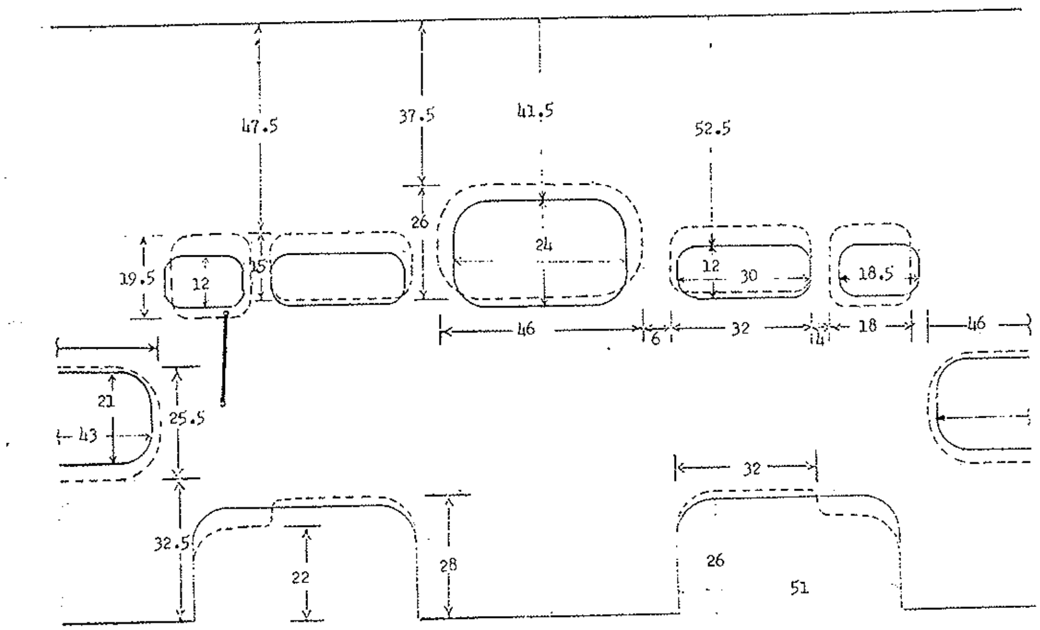


Carburetors:

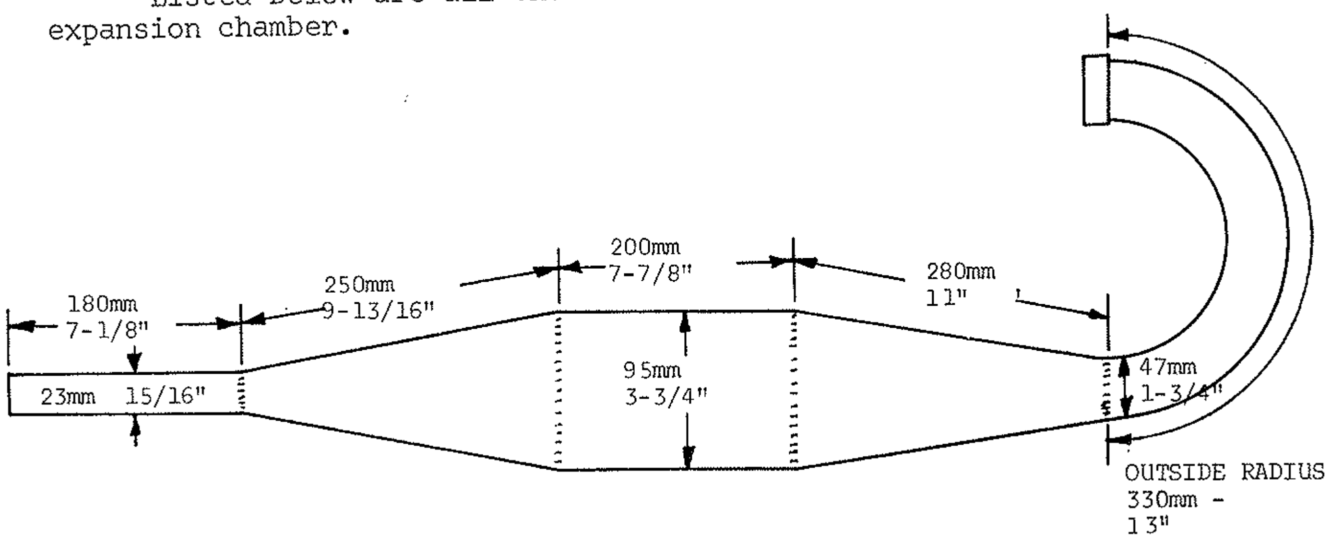
The TD2 uses 30mm carburetors.

Piston:
The GYT piston is 4 mm shorter, has the transfer hole cut away 4 mm higher, and it carries only one ring.

Cylinder:
The illustration below compares the standard porting (solid line) to the GYT porting (dotted line). All dimensions are in millimeters.



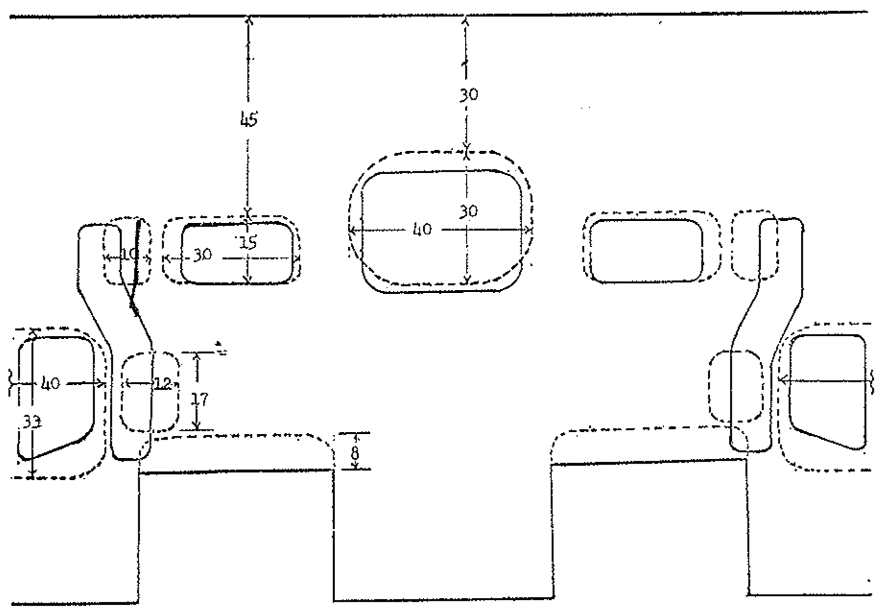
Expansion Chamber:
Listed below are all the dimensions needed to construct a GYT expansion chamber.



Head Displacement:
A standard head displaces 37.5 cc's, the GYT head displaces 27.5 cc's. See the L1 head modifications for the proper method of remachining the taper back onto the bottom edge of the combustion chamber.

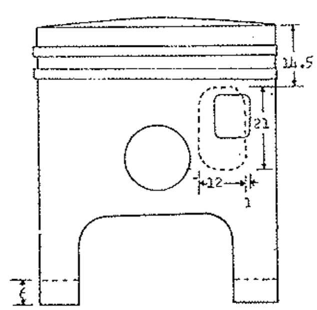
Cylinder:

The dimensions given below compare the stock porting (solid line) to the road racer porting (dotted line). You will notice that it is impossible to modify a standard cylinder to completely match the road racer specifications because the 4th and 5th transfer ports are not grooves, but actual cast-in ports. (All figures are in millimeters)



Piston:

The standard piston is shown in a solid line; the road racer piston is shown by the dotted line.

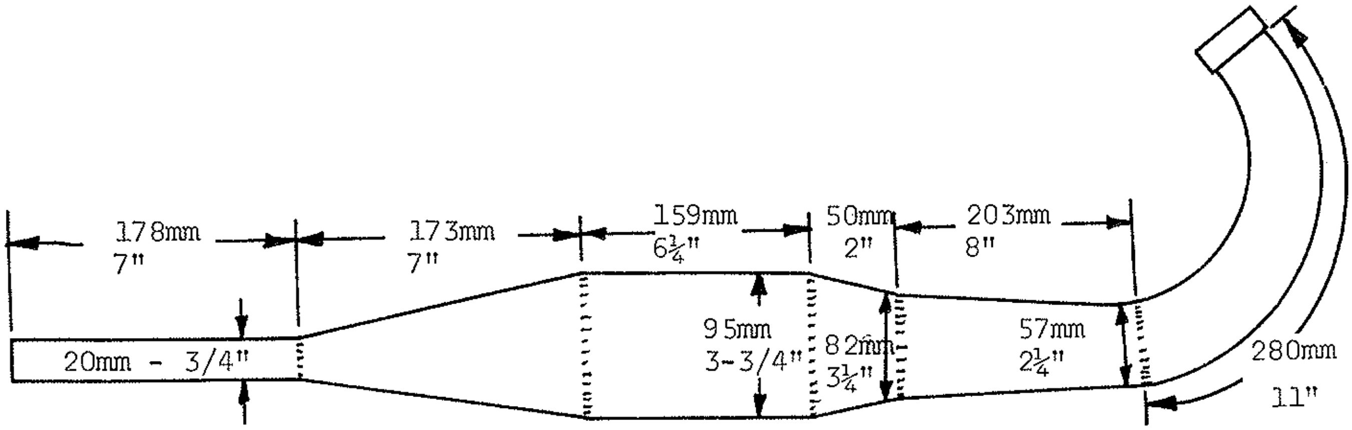


Head Displacement:

A stock head that has been machined to match the road racer head will have a displacement of 16.3 cc's. Be sure that the taper of this combustion chamber edge is machined back in. Check the L1 head modifications for a picture illustrating how the taper is machined back in.

Expansion Chamber:

Listed below are all the dimensions needed to construct the road racing expansion chamber.



APPENDIX I: SERVICE SPECIFICATIONS

The information listed on the following pages includes the general service specifications for all models from 1966 to 1969.

1. MODEL	U5	YJ1	Early YJ2	New YJ2	YG1 (S & T) (MG1T)	YG1K (S & T)	G5S	YG5T
2. BORE x STROKE (mm)	40 x 40	42 x 40	42 x 42	42 x 42	47 x 42	47 x 42	47 x 42	47 x 42
3. CAPACITY (cc)	50	55	58	58	73	73	73	73
4. COMPRESSION RATIO	6.8:1	7.1:1	6.6:1	7.5:1	6.8:1	6.8:1	6.8:1	6.8:1
5. IGNITION TIMING BEFORE T.D.C. (inch)	.065 -.077	.079 - .087	.065 -.077	.065 -.077	.079 -.087	.079 - .087	.070	.070
IGNITION TIMING BEFORE T.D.C. (mm)	1.8	2.0	1.8	1.8	2.0	2.0	1.8	1.8
6. CONTACT BREAKER POINT GAP SETTING (inch)	.008 - .016	.008 - .016	.008 - .016	.008 - .016	.008 - .016	.008 - .016	.011 - .013	.011 - .013
CONTACT BREAKER POINT GAP SETTING (mm)	.2 - .4	.2 - .4	.2 - .4	.2 - .4	.2 - .4	.2 - .4	.3 - .35	.3 - .35
7. SPARK PLUG & SPARK GAP (mm)	B7HZ .6 - .7mm	B7HZ .6 - .7mm	B7HZ .6 - .7mm	B8HC .6 - .7mm	B7HZ .6 - .7mm	B7HZ .6 - .7mm	B7HZ .5 - .6mm	B7HZ .6 - .7mm
8. VOLTAGE REGULATOR ADJUSTMENT (no load adjustment)	MAGNETO	MAGNETO	MAGNETO	MAGNETO	MAGNETO	MAGNETO	MAGNETO	15.6-16.3/2500
9. CUTOUT RELAY ADJUSTMENT (cut-in voltage)								12.5 - 13.5
10. CONDENSER CAPACITY (microfarad)	.22 - .28uF	.22 - .28uF	.22 - .28uF	.22 - .28uF	.22 - .28uF	.22 - .28uF	.25uF	.20 - .25 uF
11. PISTON SKIRT CLEARANCE (inch)	.0012 - .0014	.0015 - .0016	.0014 - .0016	.0014 - .0016	.0015 - .0016	.0015 - .0016	.0016 - .0018	.0016 - .0018
PISTON SKIRT CLEARANCE (mm)	.030 - .035	.038 - .040	.035 - .040	.035 - .040	.038 - .040	.038 - .040	.040 - .045	.040 - .045
12. CARBURETOR TYPE (Mikuni)	VM14	VM14SC	VM14SC	VM16	VM15SC-1	VM15SC-1	VM16SC	VM16SC
MAIN JET	100	95	100	60	100	100	100	120
AIR JET	2.0	0.5	–	–	0.5	0.5	.5	0.5
NEEDLE JET	E-O	E-O	E-O	E-O	E-O	E-2	E-2	E-2
JET NEEDLE	3N2-2	3G1-3	3G1-2	3D1-3	3G1-3	3G1-2	3G9-3	3G9-4
CUTAWAY	3.0	1.5	1.5	1.5	1.5	1.5	2.5	2.5
PILOT JET	17.5	15	17.5	17.5	20	17.5	25	25
AIR SCREW (turns out)	1¼	1½	1½	1½	1½	1¾	1¾	1½
STARTER JET	30	30	30	15	20	40	30	30
FLOAT LEVEL (mm)	23	23	23	23	23	23	20.5	20.5
13. PRIMARY REDUCTION RATIO	3.895 (74/19)	3.895 (74/19)	3.895 (74/19)	3.895 (74/19)	3.895 (74/19)	3.895 (74/19)	3.895 (74/19)	3.895 (74/19)
14. SECONDARY REDUCTION RATIO	2.715 (38/14)	2.786 (39/14)	2.600 (39/15)	2.533 (38/15)	2.467 (37/15)	2.467 (37/15)	2.643 (37/14)	2.740 (41/15)
15. GEAR BOX GEAR RATIO 1st	3.083 (37/12)	3.083 (37/12)	3.083 (37/12)	3.083 (37/12)	3.083 (37/12)	3.083 (37/12)	3.077 (40/13)	3.077 (40/13)
2nd	1.722 (31/18)	1.882 (32/17)	1.862 (32/17)	1.882 (32/17)	1.882 (32/17)	1.882 (32/17)	1.889 (34/18)	1.889 (34/18)
3rd	1.174 (27/23)	1.333 (28/21)	1.333 (28/21)	1.333 (28/21)	1.333 (28/21)	1.333 (28/21)	1.304 (30/23)	1.304 (30/23)
4th	– –	1.000 (25/25)	1.000 (25/25)	1.000 (25/25)	1.000 (25/25)	1.000 (25/25)	.963 (20/27)	.963 (20/27)
5th	– –	– –	– –	– –	– –	– –	– –	– –
16. GEAR BOX OIL CAPACITY (quart)	.5	.5	.5	.5	.5	.5	.66	.66
17. OIL TANK CAPACITY (quart)	1.6	–	1.16	1.16	–	1.15	1.5	1.48
18. FUEL TANK CAPACITY (gal.)	.9	1.38	1.38	1.38	1.72	1.72	1.6	1.6
19. FRONT FORK OIL CAPACITY (oz.)	–	–	4.4	4.4	4.35	4.35	5.1	4.7
FRONT FORK OIL CAPACITY (cc)	–	–	130	130	130	130	150	140
20. TIRE SIZE-FRONT	2.25 x 17	2.25 x 17	2.25 x 17	2.25 x 17	2.50 x 17	2.50 x 17	2.50 x 17	2.50 x 17
TIRE SIZE-REAR	2.25 x 17	2.25 x 17	2.25 x 17	2.25 x 17	2.50 x 17	2.50 x 17	2.50 x 17	3.00 x 17
21. TIRE PRESSURE-FRONT (lb)	22 lbs.	22 lbs.	22 lbs.	22 lbs.	22 lbs.	22 lbs.	26	24 - 26
TIRE PRESSURE-REAR (lb)	28 lbs.	28 lbs.	28 lbs.	28 lbs.	28 lbs.	28 lbs.	28	26 - 28
22. CHAIN TENSION (up and down free play)	1/2"x5/8"	1/2" - 5/8"	1/2" - 5/8"	1/2" - 5/8"	1/2" - 5/8"	1/2" - 5/8"	20mm (25/32")	1/2" - 5/8"
23. OIL PUMP ADJUSTMENT-MINIMUM STROKE (mm)	.22 - .26	–	.22 - .26	.22 - .26	–	.22 - .26	.20 - .25	.2 - .25
OIL PUMP ADJUSTMENT-MAXIMUM STROKE (mm)	1.68 - 1.85	–	1.68 - 1.85	1.68 - 1.85	–	1.68 - 1.85	1.70 - 1.95	1.70 - 1.95
24. AUTOLUBE CABLE ADJUSTMENT (throttle position)	Half-open		Half-open	Half-open		Half-open	Half-open	Half-open

1. MODEL	YL1	YL1-E	YL2	YL2-C	L5T	YA6	AT1	AT1M
2. BORE x STROKE (mm)	38 x 43 (x 2)	38 x 43 (x 2)	52 x 45.6	52 x 45.6	52 x 45.6	56 x 50	56 x 50	56 x 50
3. CAPACITY (cc)	98	98	97	97	97	123	123	123
4. COMPRESSION RATIO	7.1:1	7.1:1	7.0:1	7.0:1	6.8:1	6.8:1	7.1:1	8.0:1
5. IGNITION TIMING BEFORE T.D.C. (inch)	.065 - .077	.070	.070	.070	.070	.098	.070	.079
IGNITION TIMING BEFORE T.D.C. (mm)	1.8	1.8	1.8	1.8	1.8	2.4	1.8	2.0
6. CONTACT BREAKER POINT GAP SETTING (inch)	.011 - .013	.011 - .013	.011 - .013	.011 - .013	.011 - .013	.011 - .013	.011 - .013	.011 - .013
CONTACT BREAKER POINT GAP SETTING (mm)	.3 - .35	.3 - .35	.3 - .35	.3 - .35	.3 - .35	.3 - .35	.3 - .35	.3 - .35
7. SPARK PLUG & SPARK GAP (mm)	B7HZ .6 - .7mm	B8HC .6 - .7mm	B8HC .6 - .7mm	B8HC .6 - .7mm	B8HC .5 - .6mm	B7HZ .6 - .7mm	B8E .5 - .6mm	B9E .5 - .6mm
8. VOLTAGE REGULATOR ADJUSTMENT (no load adjustment)	15.6 - 16.3/2500	15.6 - 16.3/2500	15.6 - 16.3/2500	15.6 - 16.3/2500	15.8 - 16.5V/2500 RPM	15.3 - 16.2/3000	15.8 - 16.5V/2500 RPM	MAGNETO
9. CUTOUT RELAY ADJUSTMENT (cut-in voltage)	12.5 - 13.5	12.5 - 13.5	12.5 - 13.5	12.5 - 13.5	13V ± .5	12.5 - 13.5	13V ± .5	
10. CONDENSER CAPACITY (microfarad)	.20 - .25mm	.20 - .25mm	.20 - .25mm	.20 - .25mm	.22uF	.20 - .25mm	.22uF	.30uF
11. PISTON SKIRT CLEARANCE (inch)	.0014 - .0016	.0015	.0015	.0015	.0016 - .0018	.0016 - .0018	.0016 - .0018	.0016 - .0020
PISTON SKIRT CLEARANCE (mm)	.035 - .040	.035 - .040	.035 - .040	.035 - .040	.040 - .045	.040 - .045	.040 - .045	.040 - .050
12. CARBURETOR TYPE (Mikuni)	VM16 (x 2)	VM16SC (x 2)	VM17SC	VM17SC	VM20SC	VM22SC	VM24SH	VM26SH
MAIN JET	60	60	120	120	180	190	150	170
AIR JET	–	2.0	2.0	2.0	2.0	2.0	–	–
NEEDLE JET	E-O	E-O	D-O	D-O	O-8	0-0	N-8	0-2
JET NEEDLE	3D3-3	3D3-3	3D3-3	3D3-3	4D7-3	4J6-3	4D3-3	4D3-3
CUTAWAY	1.5	1.5	2.0	2.0	2.0	2.5	2.0	1.5
PILOT JET	17.5	17.5	20	20	20	30	30	30
AIR SCREW (turns out)	2¼	2½	1½	1½	1½	1½	1½	1½
STARTER JET	15	15	40	40	40	110	40	40
FLOAT LEVEL (mm)	23	23	22	22	22.0	25	25.5	25.5
13. PRIMARY REDUCTION RATIO	3.895 (74/19)	3.894 (74/19)	3.895 (74/19)	3.895 (74/19)	3.895 (74/19)	3.833 (69/18)	3.895 (74/19)	3.895 (74/19)
14. SECONDARY REDUCTION RATIO	2.333 (35/15)	2.335 (35/15)	2.335 (35/15)	2.335 (35/15)	2.310 (37/16)	2.600 (39/15)	3.214 (45/14)	3.267 (49/15)
15. GEAR BOX GEAR RATIO 1st	3.077 (40/13)	3.077 (40/13)	3.077 (40/13)	3.077 (40/13)	2.833 (High) 4.647 (Low)	2.533 (38/15)	3.182 (35/11)	3.182 (35/11)
2nd	1.889 (34/18)	1.889 (34/18)	1.889 (34/18)	1.889 (34/18)	1.647 (High) 2.702 (Low)	1.524 (32/21)	2.000 (30/15)	2.000 (30/15)
3rd	1.304 (30/23)	1.304 (30/23)	1.304 (30/23)	1.304 (30/23)	1.000 (High) 1.640 (Low)	1.120 (28/25)	1.368 (26/19)	1.368 (26/19)
4th	.963 (26/27)	.963 (26/27)	.963 (26/27)	.963 (26/27)	–	.828 (24/29)	1.000 (23/23)	1.000 (23/23)
5th	– –	– –	– –	– –	– –	– –	.800 (20/25)	.800 (20/25)
16. GEAR BOX OIL CAPACITY (quart)	.75	.75	.75	.75	.69	1.4	.78	.78
17. OIL TANK CAPACITY (quart)	1.16	1.16	1.7	1.7	1.5	1.9	1.3	1.3
18. FUEL TANK CAPACITY (gal.)	1.95	1.95	2.2	2.2	1.8	2.38	1.9	1.9
19. FRONT FORK OIL CAPACITY (oz.)	4.4	4.4	4.9	4.9	4.7	5.6 - 5.75	5.4	5.4
FRONT FORK OIL CAPACITY (cc)	130	130	145	145	140	165-170	160	145 - 160
20. TIRE SIZE-FRONT	2.50 x 17	2.50 x 17	2.50 x 18	3.00 x 18	2.75 x 17	3.00 x 16	3.00 x 18	3.25 x 18
TIRE SIZE-REAR	2.50 x 17	2.50 x 17	2.50 x 18	3.00 x 18	3.00 x 17	3.00 x 16	3.25 x 18	3.50 x 18
21. TIRE PRESSURE-FRONT (lb)	22 lbs.	24 - 26	24 - 26	24 - 26	26	22 lbs.	14	14
TIRE PRESSURE-REAR (lb)	28 lbs.	26 - 28	26 - 28	26 - 28	28	28 lbs.	17	17
22. CHAIN TENSION (up and down free play)	1/2" - 5/8"	1/2" - 5/8"	1/2" - 5/8"	1/2" - 5/8"	20mm (25/32)	5/8" - 3/4"	20mm (25/32)	20mm (25/32")
23. OIL PUMP ADJUSTMENT - MINIMUM STROKE (mm)	.22 - .26	.20 - .25	.20 - .25	.20 - .25	.20 - .25	.22 - .26	.20 - .25	.20 - .25
OIL PUMP ADJUSTMENT - MAXIMUM STROKE (mm)	1.68 - 1.85	1.66 - 1.85	1.85 - 2.05	1.85 - 2.05	1.85 - 2.05	1.85 - 2.05	1.85 - 2.05	1.85 - 2.05
24. AUTOLUBE CABLE ADJUSTMENT (throttle position)	At Idle	At Idle	Half-open	Half-open	Half-open	At Idle	At Idle	At Idle

1. MODEL	YAS1	AS2C	YCS-1	YCS1C	CT1	YDS2	Early YDS3	Early YDS3C
2. BORE x STROKE (mm)	43 x 43 (x 2)	43 x 43 (x 2)	50 x 46 (x 2)	50 x 46 (x 2)	66 x 50	56 x 50 (x 2)	56 x 50 (x 2)	56 x 50 (x 2)
3. CAPACITY (cc)	124	124	180	180	171	246	246	246
4. COMPRESSION RATIO	7.0 :1	7.0:1	6.8:1	7.0:1	6.75:1	7.5:1	7.5:1	7.8:1
5. IGNITION TIMING BEFORE T.D.C. (inch)	.070	.070	.070	.070	.070	.067 - .071	.071 - .075	.071 - .075
IGNITION TIMING BEFORE T.D.C. (mm)	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
6. CONTACT BREAKER POINT GAP SETTING (inch)	.011 - .013	.011 - .013	.011 - .013	.011 - .013	.011 - .013	.011 - .013	.011 - .013	.011 - .013
CONTACT BREAKER POINT GAP SETTING (mm)	.3 - .35	.3 - .35	.3 - .35	.3 - .35	.3 - .35	.3 - .35	.3 - .35	.3 - .35
7. SPARK PLUG & SPARK GAP (mm)	B9HC .5 - .6mm	B9HC .5 - .6mm	B8HC .6 - .7mm	B8HC .5 - .6mm	B8E .5 - .6mm	B7HZ .6 - .7mm	B8HC .6 - .7mm	B8HC .6 - .7mm
8. VOLTAGE REGULATOR ADJUSTMENT (no load adjustment)	ALTERNATOR	ALTERNATOR	15.6 - 16.3/2500	15.6 - 16.3/2500	MAGNETO	7.6 - 8/3500	7.1 - 7.7/3000	7.1 - 7.7/3000
9. CUTOUT RELAY ADJUSTMENT (cut-in voltage)			12.5 - 13.5	12.5 - 13.5		6.5 - 7.0	6.5 - 7.0	6.5 - 7.0
10. CONDENSER CAPACITY (microfarad)		.22uF	.20 - .25uF	.20 - .25uF	.30uF	.20 - .25uF	.20 - 0.25uF	.20 - .25uF
11. PISTON SKIRT CLEARANCE (inch)	.0020 - .0022	.0020 - .0022	.0015	.0012 - .0014	.0016 - .0018	.0022 - .0024	.0020 - .0022	.0020 - .0022
PISTON SKIRT CLEARANCE (mm)	.050 - .055	.050 - .055	.030 - .035	.030 - .035	.040 - .045	.055 - .060	.050 - .055	.050 - .055
12. CARBURETOR TYPE (Mikuni)	VM17SC (x 2)	VM17SC (x 2)	VM18SC (x 2)	VM20SC (x 2)	VM24SH	VM20SH (x 2)	VM24SC (x 2)	VM24SC (x 2)
MAIN JET	95	95	65	65	150	80	120	120
AIR JET	0.8	.8	0.5	–	–	–	0.5	0.5
NEEDLE JET	0-0	0-0	0-0	N-6	N-8	N-6	0-0	0-0
JET NEEDLE	4D9-4	4D9-4	4D2-3	4D10-3	4D3-3	24A1-3	4D4-2	4D4-3
CUTAWAY	2.0	2.0	3.0	2.5	2.0	2.0	2.0	2.0
PILOT JET	17.5	17.5	20	30	30	25	20	20
AIR SCREW (turns out)	1¾	1¾	2	2¼	1½	1¼ - 1¾	1½	1½
STARTER JET	30	30	40	40	40	40	40	40
FLOAT LEVEL (mm)	22	22.0	21	21	25.5	25	25	25
13. PRIMARY REDUCTION RATIO	3.895 (74/19)	3.895 (74/19)	3.313 (53/16)	3.313 (53/16)	3.895 (74/19)	3.250 (65/20)	3.250 (65/20)	3.250 (65/20)
14. SECONDARY REDUCTION RATIO	2.600 (39/15)	2.600 (39/15)	2.466 (37/15)	2.667 (40/15)	2.812 (45/16)	2.600 (39/15)	2.600 (39/15)	2.733 (41/15)
15. GEAR BOX GEAR RATIO 1st	3.182 (35/11)	3.182 (35/11)	2.833 (34/12)	2.833 (34/12)	3.182 (35/11)	2.500 (35/14)	2.500 (35/14)	2.500 (35/14)
2nd	1.875 (30/16)	1.875 (30/16)	1.875 (30/16)	1.875 (30/16)	2.000 (30/15)	1.667 (30/18)	1.667 (30/18)	1.667 (30/18)
3rd	1.300 (26/20)	1.300 (26/20)	1.421 (27/19)	1.421 (27/19)	1.368 (26/19)	1.227 (27/22)	1.227 (27/22)	1.227 (27/22)
4th	1.045 (23/22)	1.045 (23/22)	1.045 (23/22)	1.045 (23/22)	1.000 (23/23)	.960 (24/25)	.960 (24/25)	1.042 (25/24)
5th	.840 (21/25)	.840 (21/25)	.840 (21/25)	.840 (21/25)	.800 (20/25)	.750 (21/28)	.750 (21/28)	.923 (24/26)
16. GEAR BOX OIL CAPACITY (quart)	.78	.78	.9	1.19	.78	1.5	1.5	1.5
17. OIL TANK CAPACITY (quart)	1.59	1.6	2.1	2.0	1.3	–	1.7	1.7
18. FUEL TANK CAPACITY (gal.)	2.5	2.0	3.4	3.0	1.9	4.13	3.7	3.7
19. FRONT FORK OIL CAPACITY (oz.)	5.4	5.4	5.8	5.8	5.1	6.7	6.7	6.7
FRONT FORK OIL CAPACITY (cc)	160	160	170	170	150	200	200	200
20. TIRE SIZE-FRONT	2.50 x 18	2.75 x 18	3.00 x 18	2.75 x 18	3.25 x 18	2.75 x 18	3.00 x 18	3.00 x 18
TIRE SIZE-REAR	2.75 x 18	3.00 x 18	3.00 x 18	3.00 x 18	3.50 x 18	2.75 x 18	3.00 x 18	3.50 x 18
21. TIRE PRESSURE-FRONT (lb)	24 - 26	26	24 - 26	24 - 26	14	22 lbs.	22 lbs.	22 lbs.
TIRE PRESSURE-REAR (lb)	26 - 28	28	26 - 28	26 - 28	17	28 lbs.	28 lbs.	28 lbs.
22. CHAIN TENSION (up and down free play)	1/2" - 5/8"	20mm (25/32")	1/2" - 5/8"	1/2" - 5/8"	20mm (25-32")	5/8" - 3/4"	5/8" - 3/4"	5/8" - 3/4"
23. OIL PUMP ADJUSTMENT - MINIMUM STROKE (mm)	.2 - .25	.20 - .25	.20 - .25	.2 - .25	.20 - .25	–	.22 - .26	.22 - .26
OIL PUMP ADJUSTMENT - MAXIMUM STROKE (mm)	1.66 - 1.91	1.66 - 1.91	2.05 - 2.27	2.05 - 2.25	1.85 - 2.05	–	2.05 - 2.25	2.05 - 2.25
24. AUTOLUBE CABLE ADJUSTMENT (throttle position)	At Idle	At Idle	At Idle	At Idle	At Idle		At Idle	At Idle

1. MODEL	New YDS3	New YDS3C	YDS3M	YDS5	DS6C	DT-1	DT-1 GYT	DT1B
2. BORE x STROKE (mm)	56 x 50 (x 2)	56 x 50 (x 2)	56 x 50 (x 2)	56 x 50 (x 2)	56 x 50 (x 2)	70 x 64	70 x 64	70 x 64
3. CAPACITY (cc)	246	246	246	246	246	246	246	246
4. COMPRESSION RATIO	7.5:1	7.5:1	8.8:1	7.5:1	7.3:1	6.8:1	8.2:1	6.8:1
5. IGNITION TIMING BEFORE T.D.C. (inch)	.065 - .077	.065 - .077	.079	.070	.070	.126	.091	.126
IGNITION TIMING BEFORE T.D.C. (mm)	1.8	1.8	2.0	1.8	1.8	3.2	2.3	3.2
6. CONTACT BREAKER POINT GAP SETTING (inch)	.011 - .013	.011 - .013	.010 - .011	.011 - .013	.011 - .013	.011 - 0.013	.011 - .013	.011 - .013
CONTACT BREAKER POINT GAP SETTING (mm)	.3 - .35	.3 - .35	.25 - .30	.30 - .35	.3 - .35	.30 - .35	.30 - .35	.3 - .35
7. SPARK PLUG & SPARK GAP (mm)	B8HC .6 - .7mm	B8HC .6 - .7mm	B8EN B9EN	B8HC .6 - .7mm	B7HZ .5 - .6mm	B-7E .5 - .6mm	B9E-B9EN .5 - .6mm	B7E(N) .5 - .6mm
8. VOLTAGE REGULATOR ADJUSTMENT (no load adjustment)	7.1 - 7.7/3000	7.1 - 7.7/3000	–	15.6 - 16.3/2500	15.6 - 16.3V/2500	MAGNETO	MAGNETO	MAGNETO
9. CUTOUT RELAY ADJUSTMENT (cut-in voltage)	6.5 - 7.0	6.5 - 7.0	–	12.5 - 13.5	13V ± .5			
10. CONDENSER CAPACITY (microfarad)	.20 - .25uF	.20 - .25uF	.20 - .25uF	.20 - .25uF	.22uF	.22uF	.22uF	.22uF
11. PISTON SKIRT CLEARANCE (inch)	.0020 - .0022	.0020 - .0022	.0022 - .0024	.0015	.0014 - .0016	.0016 - .0018	.0016 - .0020	.0016 - .0018
PISTON SKIRT CLEARANCE (mm)	.050 - .055	.050 - .055	.055 - .060	.035 - .040	.035 - .040	.040 - .045	.040 - .050	.040 - .045
12. CARBURETOR TYPE (Mikuni)	VM24 (x2)	VM24 (x 2)	VM24SC (x 2)	VM26SC (x 2)	VM26SC (x 2)	VM26SH	VM30SH	VM26SH
MAIN JET	130	130	120	120	100	150	210	160
AIR JET	0.5	0.5	0.5	0.5	.5	0.5	0.5	.5
NEEDLE JET	0-0	0-0	0-0	0-5	N-8	0-2	0-4	0-2
JET NEEDLE	4D4-2	4D4-2	24J1-3	4D3-2	4D3-3	5D1-3	8J-5D05-3	5D1-3
CUTAWAY	2.0	2.0	2.0	2.5	2.0	2.5	3.5	2.5
PILOT JET	20	20	20	30	30	35	80	35
AIR SCREW (turns out)	1½	1½	1½	1½	1½	1½	½	1½
STARTER JET	40	40	60	40	40	60	60	60
FLOAT LEVEL (mm)	25	25	–	25.5	25.5	14.1mm (separate floats)	14.1mm (separate floats)	14.1mm (separate floats)
13. PRIMARY REDUCTION RATIO	3.250 (65/20)	3.250 (65/20)	3.250 (65/20)	3.250 (65/20)	3.250 (65/20)	3.095 (65/21)	3.095 (65/21)	3.095 (65/21)
14. SECONDARY REDUCTION RATIO	2.600 (39/15)	2.733 (41/15)	2.563 (41/16)	2.733 (41/15)	2.929 (41/14)	2.933 (44/15)	3.143 (44/14)	2.933 (44/15)
15. GEAR BOX GEAR RATIO 1st	2.545 (28/11)	2.545 (28/11)	2.500 (35/14)	2.545 (28/11)	2.545 (28/11)	2.231 (29/13)	2.231 (29/13)	2.231 (29/13)
2nd	1.532 (23/15)	1.533 (23/15)	1.667 (30/18)	1.533 (23/15)	1.533 (23/15)	1.624 (26/16)	1.624 (26/16)	1.624 (26/16)
3rd	1.167 (21/18)	1.167 (21/18)	1.227 (27/22)	1.167 (21/18)	1.167 (21/18)	1.211 (23/19)	1.211 (23/19)	1.211 (23/19)
4th	.950 (19/20)	.950 (19/20)	1.042 (25/24)	.950 (19/20)	.950 (19/20)	1.000 (21/21)	1.000 (21/21)	1.000 (21/21)
5th	.773 (17/22)	.773 (17/22)	.924 (24/26)	.773 (17/22)	.773 (17/22)	.826 (19/23)	.826 (19/23)	.826 (19/23)
16. GEAR BOX OIL CAPACITY (quart)	1.7	1.7	1.5	1.75	1.7	1.06	1.06	1.06
17. OIL TANK CAPACITY (quart)	1.7	1.7	–	2.5	1.6	1.7	1.7	1.7
18. FUEL TANK CAPACITY (gal.)	3.7	3.7	4.13	4.0	2.9	2.4	2.4	2.5
19. FRONT FORK OIL CAPACITY (oz.)	6.8	6.8	6.7	6.8	6.7	7.1	7.1	7.1
FRONT FORK OIL CAPACITY (cc)	200	200	200	200	200	210	210	210
20. TIRE SIZE-FRONT	3.00 x 18	3.00 x 18	3.00 x 18	3.00 x 18	3.00 x 18	3.25 x 19	3.25 x 19	3.25 x 19
TIRE SIZE-REAR	3.25 x 18	3.50 x 18	3.25 x 18	3.25 x 18	3.50 x 18	4.00 x 18	4.00 x 18	4.00 x 18
21. TIRE PRESSURE-FRONT (lb)	22 lbs.	22 lbs.	–	22	26	12 - 14	10	14
TIRE PRESSURE-REAR (lb)	28 lbs.	28 lbs.	–	28	28	16 - 18	12	17
22. CHAIN TENSION (up and down free play)	5/8" - 3/4"	5/8" - 3/4"	–	5/8" - 3/4"	20mm (25/32")	20mm (25/32")	20mm (25/32")	20mm (25/32")
23. OIL PUMP ADJUSTMENT-MINIMUM STROKE (mm)	.22 - .26	.22 - .26	–	.20 - .25	.20 - .25	.20 - .25	.20 - .25	.20 - .25
OIL PUMP ADJUSTMENT-MAXIMUM STROKE (mm)	2.05 - 2.25	2.05 - 2.25	–	2.05 - 2.27	2.05 - 2.27	1.85 - 2.05	1.85 - 2.05	1.85 - 2.05
24. AUTOLUBE CABLE ADJUSTMENT (throttle position)	At Idle	At Idle		At Idle	At Idle	At Idle	At Idle	At Idle

1. MODEL	YM1	YM2-C	YR-1	YR2	YR2C	R3(C)
2. BORE x STROKE (mm)	60 x 54 (x 2)	60 x 54 (x 2)	61 x 59.6 (x 2)	61 x 59.6 (x 2)	61 x 59.6 (x 2)	61 x 59.6 (x 2)
3. CAPACITY (cc)	305	305	348	348	348	348
4. COMPRESSION RATIO	6.7:1	7.5:1	6.9:1	6.9:1	6.9:1	7.5:1
5. IGNITION TIMING BEFORE T.D.C. (inch)	.075 - 0.087	.083	.083	.083	.083	.082
IGNITION TIMING BEFORE T.D.C. (mm)	1.9 - 2.0	2.1	2.1	2.1	2.1	2.1
6. CONTACT BREAKER POINT GAP SETTING (inch)	.011 - .013	.011 - .013	.011 - .013	.011 - .013	.011 - .013	.011 - .013
CONTACT BREAKER POINT GAP SETTING (mm)	.3 - 0.35	.30 - 0.35	.30 - .35	.30 - 0.35	.30 - .35	.3 - .35
7. SPARK PLUG & SPARK GAP (mm)	B8HC .6 - .7mm	B8HC .6 - .7mm	B8HC .6 - .7mm	B9HC .5 - .6mm	B9HC .5 - .6mm	B9HC .5 - .6mm
8. VOLTAGE REGULATOR ADJUSTMENT (no load adjustment)	7.1 - 7.7/3000	15.6 - 16.3/2500	15.6 - 16.3/2500	15.6 - 16.3/2500	15.6 - 16.3/2500	15.6 - 16.3V/2500 RPM
9. CUTOUT RELAY ADJUSTMENT (cut-in voltage)	6.5 - 7.0	12.5 - 13.5	12.5 - 13.5	12.5 - 13.5	12.5 - 13.5	13V ± .5
10. CONDENSER CAPACITY (microfarad)	.20 - .25uF	.20 - .25uF	.20 - .25uF	.20 - .25uF	.20 - .25uF	.22uF
11. PISTON SKIRT CLEARANCE (inch)	.0021 - .0023	.0015	.0015	.0012 - .0014	.0012 - .0014	.0012 - .0014
PISTON SKIRT CLEARANCE (mm)	.053 - 0.057	.035 - .040	.035 - .040	.030 - .035	.030 - .035	.030 - .035
12. CARBURETOR TYPE (Mikuni)	VM24 (x 2)	VM26SC (x 2)	VM28SC (x 2)	VM28SC (x 2)	VM28SC (x 2)	VM28SC (x 2)
MAIN JET	130	110	190	170	170	170
AIR JET	0.5	0.5	0.5	0.5	0.5	.5
NEEDLE JET	0-0	0-5	0-2	0-2	0-2	0-2
JET NEEDLE	4D4-2	4D3-2	5D1-2	5D1-3	5D1-3	5D1-3
CUTAWAY	2.0	2.5	1.5	2.0	2.0	2.0
PILOT JET	20	30	30	30	30	30
AIR SCREW (turns out)	1½	1½	2¼	1½	1½	1½
STARTER JET	40	40	40	40	40	40
FLOAT LEVEL (mm)	25.1	25.5	25.5	25.5	25.5	25.5
13. PRIMARY REDUCTION RATIO	3.250 (65/20)	3.250 (65/20)	2.870 (66/23)	2.870 (66/23)	2.870 (66/23)	2.870 (66/23)
14. SECONDARY REDUCTION RATIO	2.353 (40/17)	2.500 (40/16)	2.563 (41/16)	2.563 (41/16)	2.730 (41/15)	2.730 (41/15)
15. GEAR BOX GEAR RATIO 1st	2.545 (28/11)	2.545 (28/11)	2.545 (28/11)	2.545 (28/11)	2.545 (28/11)	2.545 (28/11)
2nd	1.533 (23/15)	1.533 (23/15)	1.600 (24/15)	1.600 (24/15)	1.600 (24/15)	1.600 (24/15)
3rd	1.167 (21/18)	1.167 (21/18)	1.167 (21/18)	1.167 (21/18)	1.167 (21/18)	1.167 (21/18)
4th	.950 (19/20)	.950 (19/20)	.950 (19/20)	.950 (19/20)	.950 (19/20)	.950 (19/20)
5th	.773 (17/22)	.773 (17/22)	.773 (17/22)	.773 (17/22)	.773 (17/22)	.773 (17/32)
16. GEAR BOX OIL CAPACITY (quart)	1.7	1.7	1.25	1.27	1.27	1.3
17. OIL TANK CAPACITY (quart)	1.7	2.5	3.25	3.4	3.4	3.4
18. FUEL TANK CAPACITY (gal.)	3.7	4.0	4.5	3.8	3.8	4.0
19. FRONT FORK OIL CAPACITY (oz.)	6.8	6.8	8.1	8.1	8.1	8.1
FRONT FORK OIL CAPACITY (cc)	200	200	240	240	240	240
20. TIRE SIZE-FRONT	3.00 x 18	3.00 x 18	3.00 x 18	3.00 x 18	3.00 x 18	3.00 x 18
TIRE SIZE-REAR	3.25 x 18	3.25 x 18	3.25 x 18	3.50 x 18	3.50 x 18	3.50 x 18
21. TIRE PRESSURE-FRONT (lb)	22 lbs.	22	22	22	22	26
TIRE PRESSURE-REAR (lb)	28 lbs.	28	28	28	28	28
22. CHAIN TENSION (up and down free play)	5/8" - 3/4"	5/8" - 3/4"	5/8" - 3/4"	5/8" - 3/4"	5/8" - 3/4"	20mm (25/32")
23. OIL PUMP ADJUSTMENT-MINIMUM STROKE (mm)	.20 - .25	.20 - .25	.20 - .25	.20 - .25	.20 - .25	.20 - .25
OIL PUMP ADJUSTMENT-MAXIMUM STROKE (mm)	2.05 - 2.25	2.05 - 2.27	2.05 - 2.27	2.05 - 2.27	2.05 - 2.27	2.05 - 2.27
24. AUTOLUBE CABLE ADJUSTMENT (throttle position)	At Idle	At idle	At idle	At Idle	At Idle	At Idle

APPENDIX II: ELECTRICAL SPECIFICATIONS

This list, covering two pages, includes the electrical specifications for models from 1966 through 1969.

	MODEL	U5	U5E	J1 & J2	G1	G5T	G5S	L1	L1E
DYNAMO AND MAGNETO	DYNAMO TYPE	MAGNETO	STARTER DYNAMO	MAGNETO	MAGNETO	STARTER DYNAMO	MAGNETO	GENERATOR DYNAMO	STARTER DYNAMO
	POINT GAP	.30 - .35mm	.30 - .35mm	.30 - .35mm	.30 - .40mm	.30 - .35mm	.30 - .35mm	.30 - .35mm	.30 - .35mm
	BREAKER CONTACT PRESSURE	.83Kg ± 10%	.5 - .7Kg	.83Kg ± 10%	.7 - .9Kg	.7Kg ± 10%	.7Kg ± 10%	.5 - .7Kg	.5 - .7Kg
	CONDENSER CAPACITY (uF)	.3uF ± 10%	.22uF ± 10%	.3uF ± 10%	.27uF ± 10%	.22uF ± 10%	.22uF ± 10%	.22uF ± 10%	.22uF ± 10%
	STANDARD BRUSH LENGTH		5 x 8 x 20mm			4.5 x 8 x 20mm		4.5 x 8 x 20mm	5 x 8 x 20mm
	USABLE BRUSH LENGHT		11.5mm			12mm		12mm	11.5mm
	STRENGTH OF BRUSH SPRING		.4 - .56Kg			.6Kg ± 15%		.6Kg ± 10%	.4 - .56Kg
	COMMUTATOR DIAMETER		37.5mm			40mm		40mm	37.5mm
	COMMUTATOR WEAR LIMIT		2.0mm			2.0mm		2.0mm	2.0mm
	STANDARD MICA UNDERCUT		.5 - 1.0mm			.5 - 1.0mm		.5 - .8mm	.5 - 1.0mm
	MINIMUM MICA UNDERCUT		.2mm			.2mm		.2mm	.2mm
	FIELD COIL RESISTANCE		5.0 Ω			6.1 Ω		5.2 Ω	5.2 Ω
	AUTOMATIC ADVANCE		5° - 24°			5° - 22.5°			2° - 21°
	IGNITION TIMING	1.8mm BTDC	1.8mm BTDC	2.0mm BTDC	2.0mm BTDC	1.8mm BTDC	1.8mm BTDC	1.8mm BTDC	1.8mm BTDC
REGULATOR	REGULATOR TYPE		T10-6-52			RC2332W		T106-01	T106-53
	'NO LOAD' VOLTAGE ADJUSTMENT-		15.8 - 16.5V @ 2500 RPM			15.8 - 16.5V @ 2500 RPM		15.6 - 16.3V @ 2500 RPM	15.8 - 16.5V @ 3000 RPM
	YOKE GAP		.6 - .7mm					.6 - .7mm	.6 - .7mm
	CORE GAP		.4 - .7mm			1.1 - 1.2mm		.4 - .7mm	.4 - .7mm
	POINT GAP		.4 - .5mm			.3 - .4mm		.4 - .5mm	.4 - .5mm
	VOLTAGE COIL RESISTANCE ('A' to 'E')		17 Ω			18.5 Ω		17 Ω	17 Ω
CUT-OUT RELAY	CUT-IN VOLTAGE OF CUT-OUT RELAY		13V ± 0.5V			13V ± .5V		13V ± .5V	13V ± .5V
	YOKE GAP		.2mm					.2mm	.2mm
	CORE GAP		.8 - 1.0mm			.5 - .7mm		.8 - 1.0mm	.8 - 1.0mm
	POINT GAP		.6 - .8mm			.6 - .8mm		.6 - .8mm	.6 - .8mm
IGNITION COIL	SPARK TEST (MINIMUM)	6mm @ 500 RPM	6mm @ 100 RPM	6mm @ 500 RPM	6mm @ 500 RPM	7mm @ 500 RPM	7mm @ 500 RPM	6mm @ 100 RPM	6mm @ 100 RPM
	SECONDARY WINDING RESISTANCE	8 - 9K Ω	8 - 9K Ω	8 - 9K Ω	4K Ω	7 - 8K Ω	5K Ω	5 - 6K Ω	5 - 6K Ω
	PRIMARY WINDING RESISTANCE	4.5 Ω	4.5 Ω	4.9 Ω		.6 Ω	.6 Ω	4.7 Ω	4.7 Ω
STARTER RELAY	CORE GAP		1.4 - 1.5mm			1.2 - 1.4mm			1.4 - 1.5mm
	POINT GAP		1.3 - 1.4mm			1.3 - 1.5mm			1.3 - 1.4mm
	RESISTANCE		4.6 Ω			11.2 Ω			4.6 Ω
	ACTUATING VOLTAGE		10V minimum			8V minimum			10V minimum

	MODEL	L2	L2C & L5T	A6	AT1M	AT1	AS1, AS1C & AS2C	CS1 & CS1C
DYNAMO AND MAGNETO	DYNAMO TYPE	GENERATOR DYNAMO	STARTER DYNAMO	STARTER DYNAMO	MAGNETO	STARTER DYNAMO	ALTERNATOR	STARTER DYNAMO
	POINT GAP	.30 - .35mm	.30 - .35mm	.30 - .35mm	.30 - .35mm	.30 - .35mm	.30 - .35mm	.30 - .35mm
	BREAKER CONTACT PRESSURE	.7Kg ± 10%	.7Kg ± 10%	.5 - .7Kg	.65 - .85Kg	.5 - .7Kg	.6Kg ± 10%	.7Kg ± 10%
	CONDENSER CAPACITY (uF)	.22uF ± 10%	.22uF ± 10%	.22uF ± 10%	.30uF ± 10%	.22uF ± 10%	.22uF ± 10%	.22uF ± 10%
	STANDARD BRUSH LENGTH	4.5 x 8 x 20mm	4.5 x 8 x 20mm	4.5 x 8 x 19.5mm		4.5 x 9 x 20.5mm		4.5 x 8 x 20mm
	USABLE BRUSH LENGTH	12mm	12mm	11.5mm		9mm		12mm
	STRENGTH OF BRUSH SPRING	.6Kg ± 15%	.6Kg ± 15%	.4 - .5Kg		.4 - .56Kg		.6Kg ± 15%
	COMMUTATOR DIAMETER	40mm	40mm	37.5mm		38.5mm		40mm
	COMMUTATOR WEAR LIMIT	2.0mm	2.5mm	2.0mm		2.0mm		2.0mm
	STANDARD MICA UNDERCUT	.5 - 1.0mm	.5 - 1.0mm	.5 - .8mm		.5 - .8mm		.5 - 1.0mm
	MINIMUM MICA UNDERCUT	.2mm	.2mm	.2mm		.2mm		.2mm
	FIELD COIL RESISTANCE	5.2 Ω	5.2 Ω	6.8 Ω		4.8 Ω		5.0 Ω
	AUTOMATIC ADVANCE		5° - 22.5°	5° - 24°				9° - 21°
	IGNITION TIMING	1.8mm BTDC	1.8mm BTDC	2.6mm BTDC	2.0mm BTDC	1.8mm BTDC	1.8mm BTDC	1.8mm BTDC
REGULATOR	REGULATOR TYPE	RN2226J2	RC2332W	T107-52		T107-17		RC2333V
	'NO LOAD' VOLTAGE ADJUSTMENT	15.6 - 16.3V @ 2500 RPM	15.8 - 16.5V @ 2500 RPM	15.8 - 16.2V @ 3000 RPM		15.8 - 16.5V @ 2500 RPM		15.6 - 16.3V @ 2500 RPM
	YOKE GAP	.3mm	.3mm	.6 - .7mm		.6 - .7mm		.3mm
	CORE GAP	1.0 - 1.2mm	1.0 - 1.2mm	.4 - .5mm		.4 - .7mm		1.0 - 1.2mm
	POINT GAP	.3 - .4mm	.3 - .4mm	.4 - .5mm		.4 - .5mm		.3 - .4mm
	VOLTAGE COIL RESISTANCE ('A' to 'E')	18.5 Ω	18.5 Ω	14.4 Ω		11.2 Ω		18.5 Ω
CUT-OUT RELAY	CUT-IN VOLTAGE OF CUT-OUT RELAY	13V ± .5V	13V ± .5V	13V ± .5V		13V ± .5V		13V ± .5V
	YOKE GAP	.3mm	.3mm	.6 - .7mm		.2mm		.3mm
	CORE GAP	.5 - .7mm	.5 - .7mm	. - mm		.8 - 1.0mm		.3 - .5mm
	POINT GAP	.6 - .8mm	.6 - .8mm	.6 - .7mm		.6 - .8mm		.7 - .9mm
IGNITION COIL	SPARK TEST (MINIMUM)	6mm @ 100 RPM	6mm @ 100 RPM	6mm @ 100 RPM	7mm @ 500 RPM	6mm @ 100 RPM	7mm @ 500 RPM	6mm @ 100 RPM
	SECONDARY WINDING RESISTANCE	7 - 8K Ω	7 - 8K Ω	5.5K Ω	11K Ω ± 20%	11K Ω ± 20%	6 - 7K Ω	7 - 8K Ω
	PRIMARY WINDING RESISTANCE	4.8 Ω	4.8 Ω	4.9 Ω	4.9 Ω	4 Ω ± 10%	4.7 Ω	4.8 Ω
STARTER RELAY	CORE GAP		1.2 - 1.4mm	1.4 - 1.5mm				1.2 - 1.4mm
	POINT GAP		1.3 - 1.5mm	1.3 - 1.4mm		1.5mm		1.3 - 1.5mm
	RESISTANCE		11 Ω	11.3 Ω		4.5 Ω ± 15%		11.2 Ω
	ACTUATING VOLTAGE		8V minimum	8V minimum		10V minimum		8V minimum

	MODEL	CT1	DS3, DS3C, & M1	DS5	DS6C	DT1A & DT1B	M2 & M2C	R1, R2, R2C, R3, & R3C
DYNAMO AND MAGNETO	DYNAMO TYPE	MAGNETO	GENERATOR DYNAMO	STARTER DYNAMO	GENERATOR DYNAMO	MAGNETO	GENERATOR DYNAMO	GENERATOR DYNAMO
	POINT GAP	.30 - .35mm	.30 - .35mm	.30 - .35mm	.30 - .35mm	.30 - .35mm	.30 - .35mm	.30 - .35mm
	BREAKER CONTACT PRESSURE	.6 - .8Kg ± 10%	.7Kg ± 10%	.7Kg ± 10%	.7Kg ± 10%	.6Kg ± 10%	.7Kg ± 10%	.7Kg ± 10%
	CONDENSER CAPACITY (uF)	.22uF ± 10%	.22uF ± 10%	.22uF ± 10%	.22uF ± 10%	.25uF ± 10%	.22 uF ± 10%	.22uF ± 10%
	STANDARD BRUSH LENGTH		5 x 9 x 17mm	4.5 x 8 x 20mm	4.5 x 8 x 20mm		4.5 x 8 x 20mm	4.5 x 8 x 20mm
	USABLE BRUSH LENGTH		11mm	12mm	8mm		12mm	12mm
	STRENGTH OF BRUSH SPRING		.6Kg ± 15%	.6Kg ± 15%	.6Kg		.6Kg ± 10%	.6Kg ± 10%
	COMMUTATOR DIAMETER		35mm	40mm	40mm		40mm	40mm
	COMMUTATOR WEAR LIMIT		1.0mm	2.0mm	2.0mm		2.0mm	2.0mm
	STANDARD MICA UNDERCUT		.5 - 1.0mm	.5 - 1.0mm	.5 - 1.0mm		.5 - 1.0mm	.5 - 1.0mm
	MINIMUM MICA UNDERCUT		.2mm	.2mm	.2mm		.2mm	.2mm
	FIELD COIL RESISTANCE		4.2 Ω	5.0 Ω	5.57 Ω		5.6 Ω	5.6 Ω
	AUTOMATIC ADVANCE			5° - 19.5°				
	IGNITION TIMING	1.8mm BTDC	1.8mm BTDC	1.8mm BTDC	1.8mm BTDC	3.2mm BTDC	2.1mm BTDC	2.1mm BTDC
REGULATOR	REGULATOR TYPE		RN6225K	RN2225M	RN2226J		RN2226J	RN2226 (R1, R2)-R 2220J (R3)
	'NO LOAD' VOLTAGE ADJUSTMENT		7.7 - 8.1V @ 2500 RPM	15.6 - 16.3V @ 2500 RPM	15.6 - 16.3V @ 2500 RPM		15.6 - 16.3V @ 2500 RPM	15.6 - 16.3V @ 2500 RPM
	YOKE GAP		.3mm	No Adj.	No Adj.		No Adj.	No Adj.
	CORE GAP		1.1 - 1.4mm	1.0 - 1.2mm	1.0 - 1.2mm		1.0 - 1.2mm	1.0 - 1.2mm
	POINT GAP		.3 - .4mm	.3 - .4mm	.3 - .4mm		.3 - .4mm	.3 - .4mm
	VOLTAGE COIL RESISTANCE ('A' to 'E')		5.6 Ω	18.5 Ω	18.5 Ω		18.5 Ω	18.5 Ω
CUT-OUT RELAY	CUT-IN VOLTAGE OF CUT-OUT RELAY		6.5 - 7.0V	13V ± .5V	13V ± .5V		13V ± .5V	13V ± .5V
	YOKE GAP		.3mm	No Adj.	No Adj.		No Adj.	No Adj.
	CORE GAP		.3 - .5mm	.3 - .5mm	.3 - .5mm		.3 - .5mm	.3 - .5mm
	POINT GAP		.7 - .9mm	.7 - .9mm	.7 - .9mm		.7 - .9mm	.7 - .9mm
IGNITION COIL	SPARK TEST (MINIMUM)	7mm @ 500 RPM	6mm @ 100 RPM	6mm @ 100 RPM	7mm @ 700 RPM	6mm @ 500 RPM	6mm @ 100 RPM	6mm @ 100 RPM
	SECONDARY WINDING RESISTANCE	11K Ω ± 20%	5 - 6K Ω	7 - 8K Ω	8.2K Ω	5 - 6K Ω	7 - 8K Ω	7 - 8K Ω
	PRIMARY WINDING RESISTANCE	4.9 Ω	1.6 Ω	4.8 Ω	4.6 Ω	.6 Ω	4.8 Ω	4.8 Ω
STARTER RELAY	CORE GAP			1.1 - 1.3mm				
	POINT GAP			2.05 - 2.35mm				
	RESISTANCE			4.3 Ω				
	ACTUATING VOLTAGE			8V minimum				

m.m.							
0.01 --	0.00039	0.10 -	0.00393	1.00 --	0.03937	10.00 --	0.39370
.02 --	.00078	.20 --	.00787	2.00 --	.07874	20.00 --	.78740
.03 --	.00118	.30 --	.01181	3.00 --	.11811	30.00 --	1.18110
.04 --	.00157	.40 --	.01574	4.00 --	.15748	40.00 --	1.57480
.05 --	.00196	.50 --	.01968	5.00 --	.19685	50.00 --	1.96850
.06 --	.00236	.60 --	.02362	6.00 --	.23622	60.00 --	2.36220
.07 --	.00275	.70 --	02755	7.00 --	.27559	70.00 --	2.75590
.08 --	.00314	.80 --	.03149	8.00 --	.31496	80.00 --	3.14960
.09 --	.00354	.90 --	.03543	9.00 --	.35433	90.00 --	3.54330

EXAMPLES:

.76 m.m. = ? inch

m.m.		
.70	=	.02755
+ .06	=	.00236
.76	=	.02991

8.76 m.m. = ? inch

m.m.		
8.00	=	.31496
.70	=	.02755
+ .06	=	.00236
8.76		.34487

Fractional	Decimal				
1/64	.01562	11/32	.34375	43/64	.68187
1/32	.03125	23/64	.35937	11/16	.6875
3/64	.04687	3/8	.375	45/64	.70312
1/16	.06250	25/64	.39062	23/32	.71875
5/64	.07812	13/32	.40625	47/64	.73437
3/32	.09375	27/64	.42187	3/4	.750
7/64	.10937	7/16	.4375	49/64	.76562
1/8	.125	29/64	.45312	25/32	.78125
9/64	.14062	15/32	.46875	51/64	.79687
5/32	.15625	31/64	.48437	13/16	.8125
11/64	.17187	1/2	.500	53/64	.82812
3/16	.1875	33/64	.51562	27/32	.84375
13/64	.20312	17/32	.53125	55/64	.85937
7/32	.21875	35/64	.54687	7/8	.8750
15/64	.23437	9/16	.5625	57/64	.89062
1/4	.250	37/64	.57812	29/32	.90625
17/64	.26562	19/32	.59375	59/64	.92187
9/32	.28125	39/64	.60937	15/16	.9375
19/64	.29687	5/8	.625	61/64	.95312
5/16	.3125	41/64	.64062	31/32	.96875
21/64	.32812	21/32	.65625	63/64	.98437

Gallon	Quart	Pint	Liter
1	4	8	3.785
.264	1.056	2.113	1
1/4	1	2	.946
1/8	1/2	1	.473

APPENDIX IV: METRIC/AMERICAN CONVERSION FORMULAS

	Multiply (Known)	By	To Obtain (Unknown)
LENGTHS	Millimeters (mm)	0.03937	Inches
	Inches (in.)	25.4	Millimeters
	Centimeters (cm)	.3937	Inches
	Inches (in.)	2.54	Centimeters
	Kilometers (km.)	.6214	Miles
	Miles (mi.)	1.609	Kilometers
	Meters (m.)	3.281	Feet
	Feet (ft.)	.3048	Meters
WEIGHTS	Kilograms (kg.)	2.205	Pounds
	Pounds (lb.)	.4536	Kilograms
	Grams (g.)	.03527	Ounces
	Ounces (oz.)	28.35	Grams
VOLUMES	Cubic Centimeters (cc.)	.061	Cubic inches
	Cubic Inches (cu. in.)	16.387	Cubic Centimeters
	Liters (l.)	.264	Gallons
	Gallons (gal.)	3.785	Liters
	Liters (l.)	1.057	Quarts
	Quarts (qt.)	.946	Liters
	Cubic Centimeters (cc.)	.0339	Fluid ounces
	Fluid ounces (fl. oz.)	29.57	Cubic Centimeters
OTHERS	Metric horsepower (ps.)	1.014	bhp.
	Brake horsepower (bhp.)	.9859	ps.
	Kilogram-meter (kg-m)	7.235	Foot-pounds
	Foot-pounds (ft-lbs)	.1383	kg-m
	Kilometers per liter (km/l)	2.352	mpg
	Miles per gallon (mpg)	.4252	km/l
	Square millimeters (sq. mm)	0.00155	sq. in.
	Square inches (sq. in.)	645.2	sq. mm
	Kilometers per hour (km/h)	0.6214	mph
	Miles per hour (mph)	1.609	km/h

PUBLISHED BY

YAMAHA INTERNATIONAL CORPORATIONS
7733 Telegraph Road
Montebello, California 90640

First Printing May 1969

YAMAHA INTERNATIONAL CORPORATION
7733 TELEGRAPH ROAD
MONTEBELLO, CALIFORNIA 90640