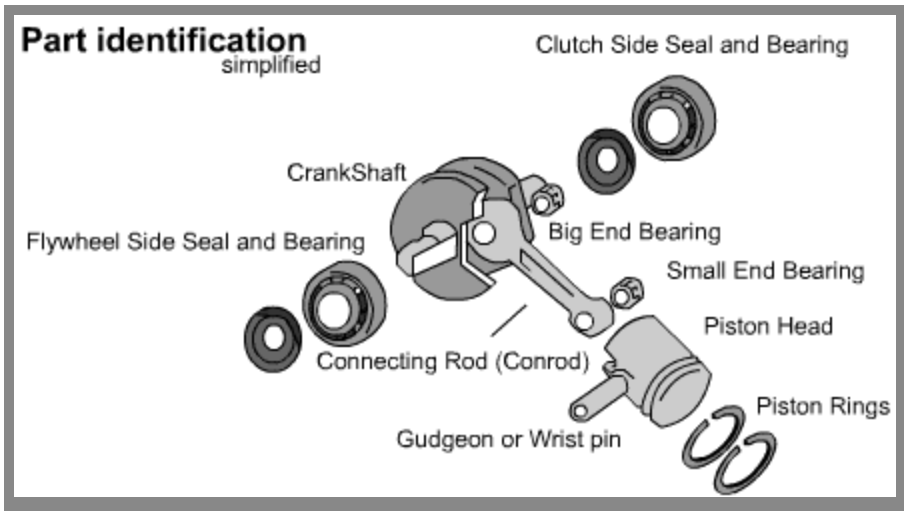
Engine Troubleshooting

This page is dedicated to engine issues. If you want to know how a P200 two stroke engine works, read my primer listed below. I have a tutorial on dropping the engine and cracking the cases to get at the cruciform. Scooterhelp.com offers a method of getting at the cruciform without dropping the engine out of the frame. Evaluate both methods and choose the one that is best for you. Before attempting these articles, read them over carefully to get a sense of how to plan them. Engines should only be cracked on a clean surface free of rocks and debris. Avoid bad weather if you are going to work outside as it will make most people rush through the job. There will be more posts as I burn more two stroke :)).

Two Stroke Primer

Welcome to my primer on two strokes. The Vespa P200 engine is a good example of a by the book rotary valve two stroke. There are only 3 moving parts in the engine's top end: no pushrods, no camshafts, no lifters, nothing you would expect to see in a 4 stroke automobile engine. In this document, I hope to enlighten even the mechanically inept on how these beasts work.



If you have ever gotten that feeling that people around you are speaking an alien language when it comes to their bikes, they're probably talking about the engine. :) Never fear, however, I have the cure. Let's have a look at the parts in the engine top-end:

First thing on the roster is the barrel, or bore, or jug - however you may have come to know it. This is the container that holds back the huge forces behind the combusting gas and directs them to the piston. This part is centered with cylinder studs and is highly polished (or honed) to allow the best seal possible. If the polished area is scratched or burnt from overheating, it can be fixed by oversizing. Oversizing can be done at specialty shops and involves machining a larger hole through the bore and buying a larger piston to fit.

Secondly, we have the piston. The piston is made of aluminum alloy and moves up and down inside the cylinder barrel, channelling the force of the combustion into the rod beneath it: the connecting rod. The rings that skirt the piston head are called piston rings. The piston rings form a tight seal to prevent gas from escaping and center the piston head in the barrel. The gudgeon pin, or wrist pin, connects the piston head to the connecting rod.

Speaking of the connecting rod, we will look at that for a minute. The connecting rod is also made of a light metal and transfers the power from the piston and pushes on the crank. There are two bearings on the connecting rod, or con-rod, the small end bearing, or the wrist bearing; and the big end bearing, or the crank pin bearing. These bearings allow a nice circular motion that occurs as your piston moves up and down inside the cylinder.

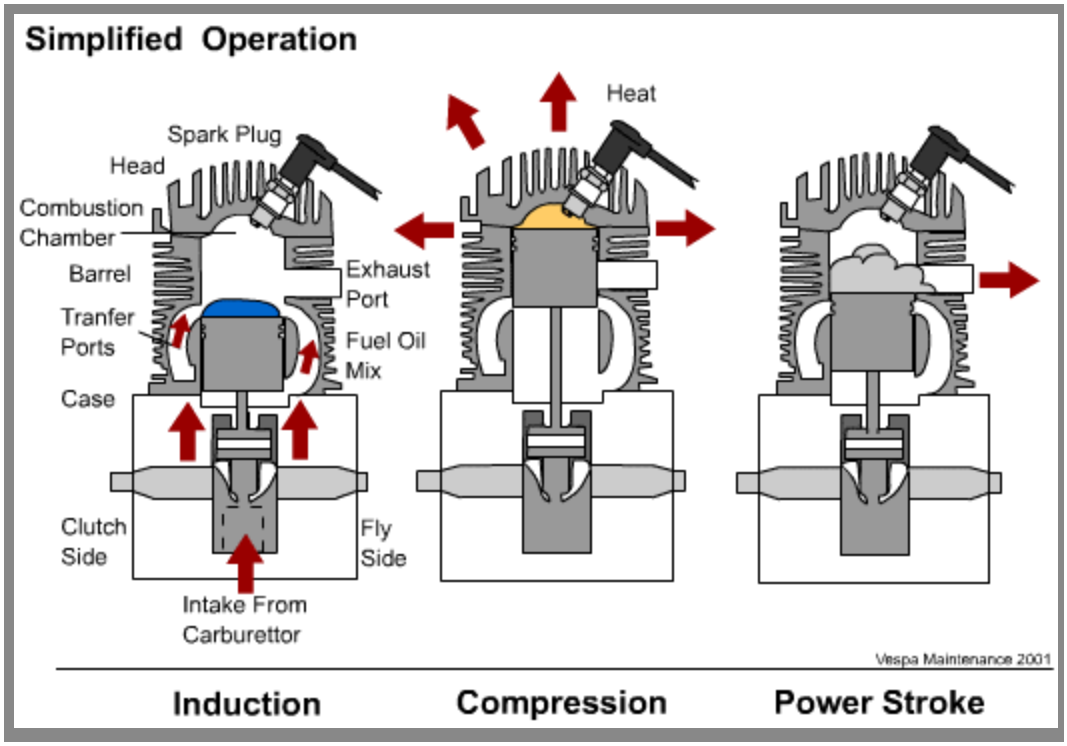
The crankshaft, or crank is another moving part within the engine. This component has an offset point, called the crank pin , inside it which turns the up-and-down motion of the piston into rotational motion necessary for gears and wheels. The crank is usually made of a really heavy metal, like steel. The crankshaft also plays a part in injecting the gas into the expansion chamber (the place where the piston lives).

The combustion chamber is the place where the compression and combustion of the gas mixture occurs. This part is in the head of the cylinder and looks like a hemisphere (see below). This is the part that your spark plug threads into.

The expansion chamber is the length of the exhaust pipe. The exhaust pipe is approximately 12 times the volume of the displacement of your engine and is 'tuned' to give you the largest power bands. The reason

for this phenomenon is that the expansion the combusting of gas is turned into force on the piston, but the gases from the combustion have to escape before the engine can take in new gas. The onus is on the exhaust to facilitate quick removal of the expended gas. The exhaust itself will be tuned such that it will contain exactly the right amount of waste vapours. This creates a pressure difference, that lets some of the exhaust gases leave the pipe and the some get pulled back into the cylinder with the new charge. The strength of this back pressure will result in better or worse performance from your motor. This is why better (tuned) exhausts are soughtafter: the stronger the back pressure, the more efficiently the engine works.

When people talk about 'good compression', they are indicating that the engine is probably in good health. Good compression means that the piston rings are well compressed and sealing properly, the cylinder head and bore are sealed well, the spark plug is tight, the engine seals are tight and the exhaust is providing good back pressure. You can test compression with a compression tester. this device measures the change in pressure when the piston reaches the top of the cylinder. A stock vespa engine typically has a compression of about 120psi. It takes 90psi minimum to start the bike. You can change the compression ratio of the motor by using different cylinder heads and maintaining the piston rings. This higher the compression ratio, the more pressure you will get, but heat will build up faster.



Induction

The engine on the P200 uses a 'disc valve' carburettion system and a 'rotary valve' induction system. What the hell am I talking about? I will explain. Disc valve induction from the carburettor is the slide moving in and out of the venturi letting more or less gas get through the hole in the bottom of the carb. Conversely, Rotary valve induction is the cut-out in the crank (you can see this if you turn your flywheel with the carb disassembled) that pulls in the gas being let through the disc valve at exactly the right time. The efficiency of the rotary valve's seal is based on the rotary pad. the rotary pad is directly below the carbuerettor inlet. This is an extremely high precision part of the motor. if it becomes scratched or dented

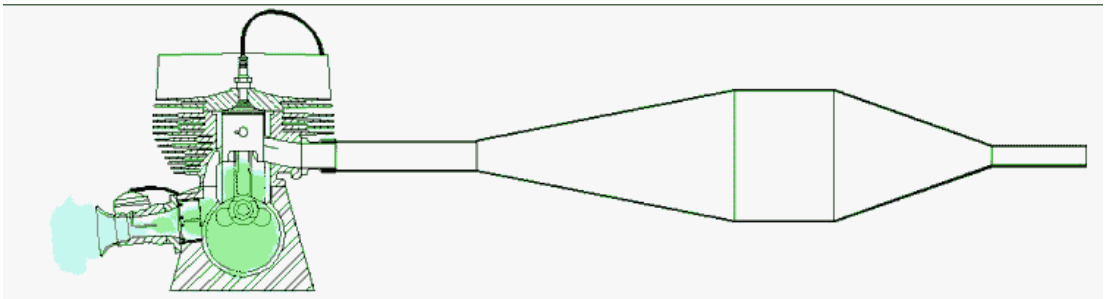
from an engine failure, the motor will not seal well and you'll lose what is known as primary compression, the compression caused by the rotary valve and engine pressure.
The engine demands a certain amount of fuel from the carb by forming a large low pressure reigon. this low pressure draws gas and air through the carb and into the motor. As the rotary valve closes, the piston has lowered in the cylinder and thus the pressure in the cylinder has changed. Therefore, the fuel mixture rushes into the cylinder. The pressures in the motor move the mixture up through the transfer ports, or channels in the bore, and onto the piston head. The purpose of the fuel mix is two-fold. Obviously, the gas is going to be burnt; however, before that happens, the two stroke oil in the gas lubricates everything it touches. The two stroke oil also forms a heat resistant shield over your piston, protecting the head surface from the gas explosion. Unlike a four stroke engine (like that in a car), a two stroke engine top-end is NOT lubricated by the gearbox oil. This is why two stroke oil has to be added to the gas. If there is no two stroke oil, or you are 'running lean', your engine will very quickly overheat and seize, and/or blow a hole through the piston.

Compression

With the gas collected, the piston continues it's travel up the bore. The heavy flywheel turns the crank and pushes the con-rod, and subsequently the piston, to the top of it's travel. As the piston reaches the top, the gas becomes compressed against the hemispherical area called the combustion chamber. Now we get into timing. When we talk about timing, we are observing the firing point of the spark plug. Ideally, the firing point should occur as the piston reaches the top dead center (TDC) of its travel. The high voltage electronics that control this firing point a take a few milliseconds to develop a spark across the spark plug. Because of this delay, we have to offset the timing to make up for it. This offset is usually measured in degrees and sets off the electronics before the piston actually gets to TDC. The spark plug develops a huge voltage and arcs through the gas, positively combusting all the gas and putting a large pressure on the piston head. This gives rise to the Power stroke.

Power Stroke

The con rod, connected to the piston and crank, transfers energy of the blast from the piston head to the crankshaft. The crank coverts the strong linear forces into equally strong rotational forces. This is where the engine develops all of its power. By the time the piston opens to the exhaust port again, the pressure in the pipe is now low and discharges the high pressure combustion exhaust into the pipe. Most of the gases escape through the tailpipe, but some are reflected to assert a strong reigon of high pressure on the exhaust port so new charge can enter the cylinder. The piston travels down to the transfer ports once again and restarts the induction process. This cycle will continue until you run out of gas or you stop the spark plug from sparking (kill the engine or turn the ignition switch).



Cleaning The Top-End (Decoking)

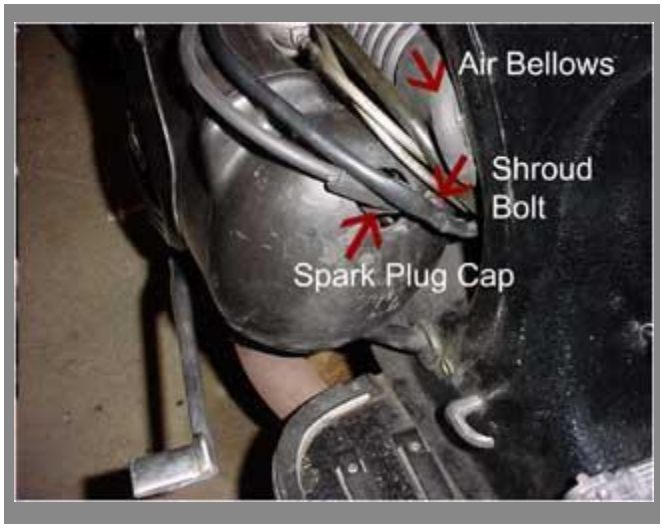
This tutorial will demonstrate the process of decoking the top end, or removing the carbon deposits from the engine. This is a standard maintenance and should be performed every 6000km (4000 miles), or every year for machines that are never heating up (quick hops about town). It will be virtually impossible to get all the crud off of the engine parts, so don't be overly compulsive about it. Though the process seems daunting, like putting a wheel together, it is one of those chores that you will be able to fly through after your first go. I would give it a few hours for the first time. I hear some asking, "why should I do this; my engine runs fine?" This procedure is important because of the heat and power restrictions a two stroke engine has to contend with. By letting junk build up on the piston, cylinder and head, you are effectively decreasing the fuel capacity of your motor (ie 200 cc to something slightly less). Since waste carbon, commonly called coke, is left from burning two stroke oil, the engine will suffer from an overly "rich" condition and generally run badly or start hard. A few signs that your top-end may need to be cleaned are oily, constantly fouling spark plugs; hard starting (more than 4 kicks) and lots of exhaust smoke. I would reccomend you preced this operation with a carb rebuild when attempting for the first time. Synthetic lubricants will increase the period of this procedure, but it is still worthwhile to consider attempting every year. This procedure is best done in a covered, well lit area (like a garage) so no crap gets into your top end.

Tools & Parts Needed
Multi Screwdriver
Spark Plug Wrench
Disposeable Shop Towels
A can of Carb Cleaner
A Tube of Anti-Sieze Lubricant
13mm and 11mm Deep Socket
Torque Wrench (Absolutely neccessary, DO NOT perform without this item)
Plastic Bondo (Body Filler) Scraper
Plastic "Wire" Brush
Tub of All-Purpose / Bearing Grease ("Green Goop")

Procedure

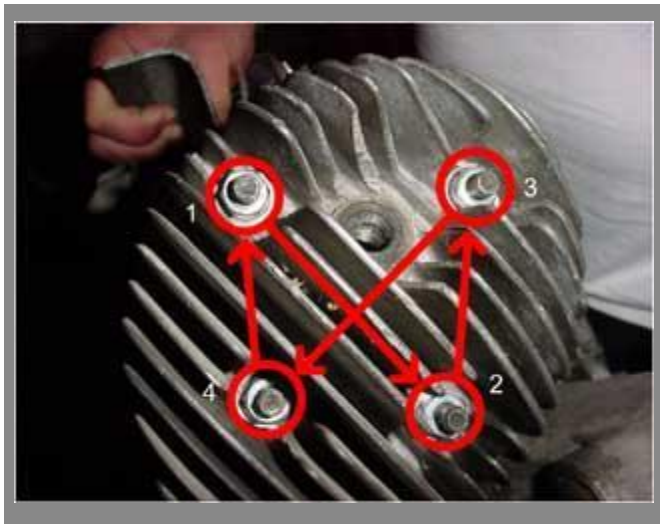
Step 1

Undo the arrowed screws and the flywheel shroud will fall right off. Put the shroud and all the little screws in a safe place (or sand it down and paint it if you have a day or two).



Step 2

Gently prise off the spark plug connector and put it one side. Undo the Shroud bolt right next to the spark plug. Unhook the air bellows from the frame and push it to one side. Slide the cylinder shroud off of the engine by pulling towards the front of the bike. You should now be able to see the cylinder. Remove the sparkplug with the sparkplug wrench.



Step 3

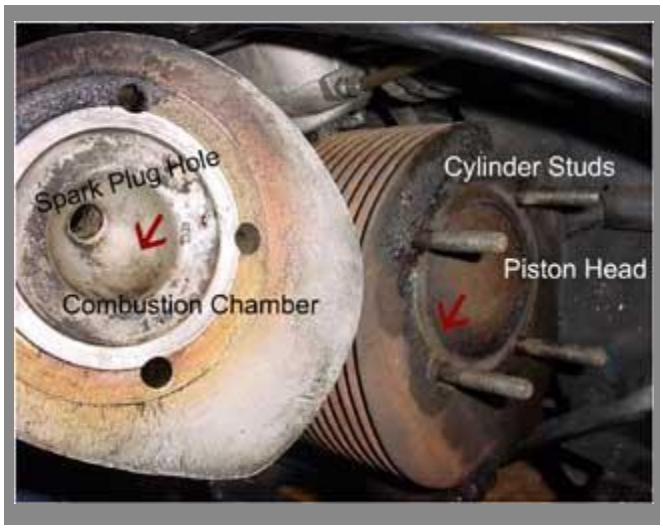
Remove the nuts by loosening them slowly in this order. Do a quarter turn, go to the next, quarter turn, next, quarter turn, next, etc. until the nuts are removed. This will take a while, but you risk bending the aluminum head if you don't do them in small steps and in order. The same is true for tightening. Carefully collect the hardware and remove the cylinder head.

Step 4

Since the flywheel is connected to the crank, you can raise and lower the piston simply by turning the flywheel by hand. To start, position the piston to the top of the bore. You are now ready to start cleaning.

Step 5

With the piston at the top of the bore, rub a ring of all purpose grease around the circumference of the piston head. This will catch any little chunks of carbon. If your piston is totally coated in carbon (like mine) use a plastic scraper to get most of the crud off. When you are done scraping, remove the remainder with a plastic "wire" brush. Metal is NOT reccomended.

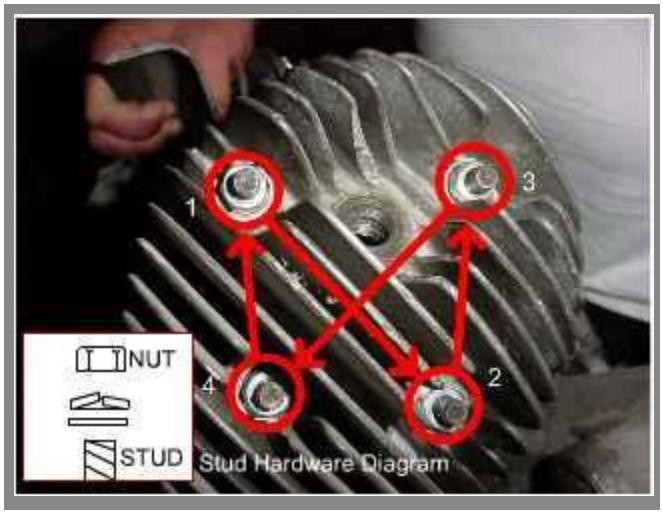


Step 6

Wipe off all of the grease from the scraping. To clean the sides of the piston and bore, apply another ring of grease and turn the flywheel slowly. The piston will recede into the bore. Go halfway down, rub away some of the grease with a disposeable towel then go to the bottom and repeat. Keep re-applying grease until the metal on the bore is clean.

Step 7

To clean the cylinder head, use copious amounts of carb cleaner and shop towel, the carbon doesn't tend to stick quite as badly to the head and there's more room to work on it. This part, if any, should be sparkly aluminum grey by the end. Once you finish cleaning the head, spread some anti sieze lubricant (stops threads from stripping) on the thread on the cylinder studs.



Step 8

Put the head back on. Hand tighten the screws in order until each becomes snug. Then, using the quarter turn method, tighten the screws with a torque wrench, in order, using a torque of 1.7-2.2 kgf m (12.30-15.91 lbf ft). Re assemble the bodywork in the reverse order. Install the Spark Plug last and reconnect the bellows be stretching

the rubber around the lip on the frame.

Once all the panels are back on the bike, kick start the engine as usual. The engine should roar to life after a few kicks. If the kickstart lever doesn't feel firm or if the the engine will only run when the choke is turned on, you have an air leak. This will probably be caused by the sparkplug not being tight enough (*The plug is touchy, don't tighten it too strongly or you will rip the threads out of the aluminum*). If you did rip the threads, there will be a leak around the damage -- take the piece to a machine shop and have them install a "helicoil insert", and remind them of the fact it is a cylinder head so they can use a high heat transfer coil. This will replace the old threads and make a much stronger thread. If the plug IS seated properly, the cylinder head may be warped from improper tightening. IF YOU FOLLOW THE RULES, THIS WILL NOT HAPPEN. However, if it is warped, you will need some 400 grit wet/dry sandpaper and a piece of glass. Tape the paper to the glass and wet it. Hold the cylinder head in your palm and rotate the bottom on the paper until it is flat. Once you are done remount it and try again. This maintenance should be done yearly for year round riders, every 6000km (4000 miles) for the "rally only" types.

Dropping the Engine

If you are getting into more serious engine repairs, such as rebuilding, replacing seals, changing the cruciform, fixing the clutch, changing bearings or fixing the kickstart mechanism, it is highly recommended that you drop the engine out of the frame. Not only will this give you more room to work, but it will also lower the risk of damage and lost parts in the engine. Dropping the engine requires two people and a solid hour's work. You will have to strip the frame electrical and cable connections, otherwise the engine will snag as it is pulled away. Take care not to rush this step and perform it indoors so weather does not expediate the work. Since this operation will lead to cracking the cases, it is a good idea to buy all the seals (see part list) so you can replace them when the repairs are finished. Any good seals not worn or see through, in the case of gaskets, are always an asset. Replace them with a new seal, but keep the old one in your toolkit. This is a major operation, but don't let it seem intimidating. Vespa engines are relatively simple inside. Just work in a clean environment and proceed slowly if you are unsure about a part. MAKE SURE YOU RUN THE BIKE WITH THE FUEL TAP SET TO "OFF" UNTIL THE ENGINE DIES OUT, SO NO GAS IS SPILLED!!! A Haynes manual alongside this tutorial will help greatly.

Tools & Parts Needed
Socket Set (7-22mm)
Spanner set (7-22mm)
Long Handled Screwdriver Set
Spark Plug Wrench

Disposeable Shop Towels
A can of Carb Cleaner
A can of WD-40
Split Pin for Rear hub
Metal Hammer
Visegrips
Needlenose pliers
A length of pipe larger than the diameter the handle of your socket driver
A Large Chisel (see below)
A large bag and electrical tape
A clutch Cable inner
A rear brake cable inner

Buy the following parts at your discretion
Set of Woodruff Keys (Flywheel and Clutch side)
Rear brake Shoes
Gaskets: Case gasket, Air Box to Case gasket, Selector Box Gasket, Clutch Cover O-Ring, Cylinder to Base Gasket, Oil Drain Plug Gasket.
Seals: Flywheel Side Seal, Clutch Side Seal, Rear hub Seal

Procedure

Step 1

Prop the bike on large boxes and shim further with wood planks. This will make the bike more accessible and less susceptible to falling over. After standing the bike, disconnect the ground lead from the battery to prevent short circuits.

Step 2

Undo the oil drain plug screw with a spanner and allow oil to drain out of the bike. There is not much oil in the gearbox, so a 10" pieplate should sufficiently hold the oil. Drain the oil into a cranberry juice bottle using a siphon and take it to the nearest recycling station.

Step 3

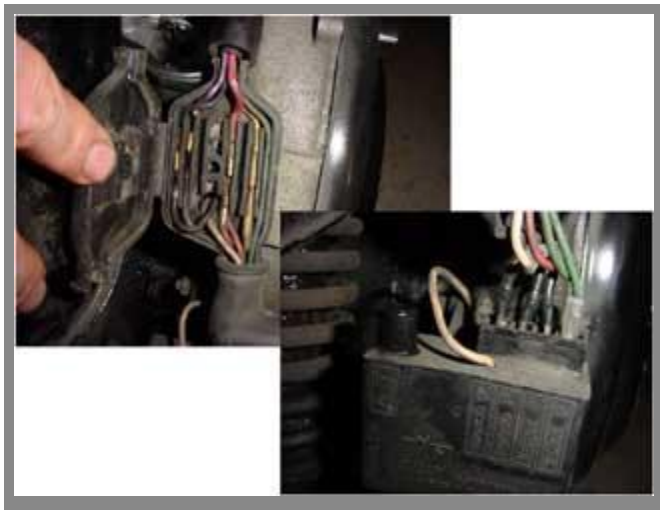
Remove the split pin in the center of the hub with a small pair of pliers. Using a 22mm Socket, loosen the castellated nut. If it refuses to budge, have a friend apply the rear brake add the pipe length to your socket handle to give more leverage. The bolt should budge quickly. Collect the castellated nut and the large spacer washer

Step 4

Pull the wheel away from the hub to reveal the brakes and rear axle. If the brakes are considerably worn, indicated by poor stopping or inability to lock the rear wheel, replace both shoes AFTER the repairs to the engine are completed. Wheels tend to be covered in soot from the exhaust, wipe clean with a small spray of carb cleaner.

Step 5

Wrap a clean plastic bag around the brake shoes making sure the lip of the bag pushes behind the shoes and tape it with vinyl electrical tape. Since oil will spill everywhere during the disassembly, this step is very important to prevent damage to the brake shooes.

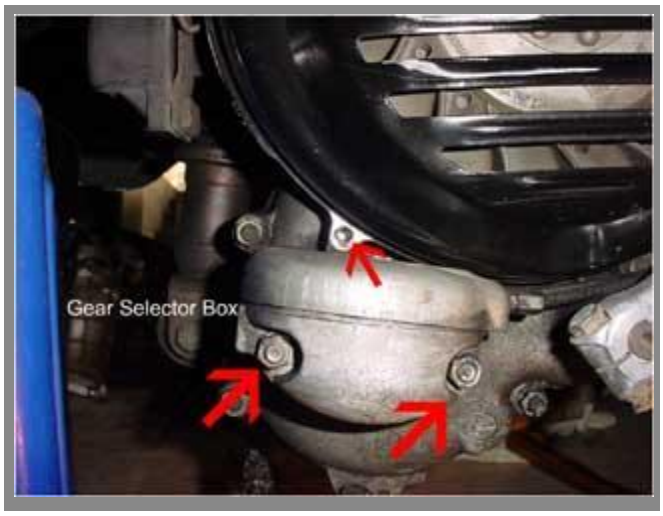


Step 6

Open the juction box by removing the screw in the top of the door and disconnect all connections inside the box noting wiring configuration. Pull back the CDI rubber to remove the connections from the CDI box. Pull the frame electrical connections from the top junction box.

Step 7

Disconnect the rear brake cable from the brake arm. A small socket will loosen the nut and allow the inner to slide out. Pull the inner cable and the outer cable completely clear of the engine.

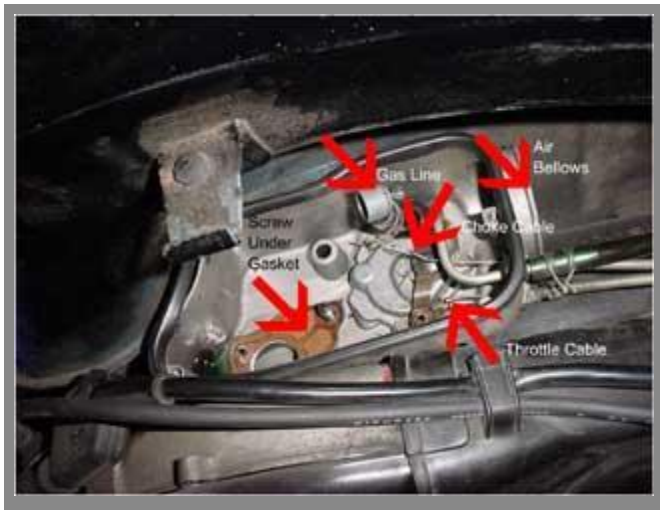


Step 8

You will have to remove the gear selector box. Remove the Cylinder and flywheel shroud by removing their respective screws. The Selector box cover will lift away with the flywheel shroud. Undo the small nuts on the selector box and carefully collect the hardware under the nuts.

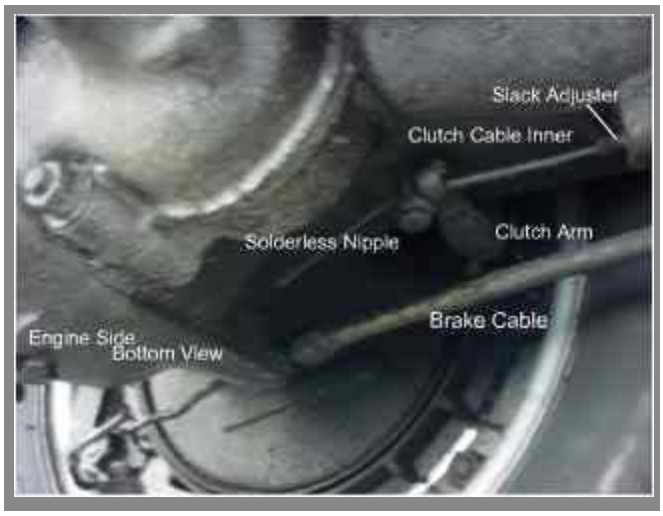
Step 9

Get a friend to shift from first gear to fourth gear. This action will lever off the gear selector box and allow you to remove it from the engine. Have the pieplate ready for more oil. You don't need to loosen the gear selector cables, in fact I don't reccomend it unless the selector box requires further inspection.



Step 10

You will have to remove the carburettor and air box. There is a dissassembly guide in the carburettor rebuild section if this picture is not completely clear. Undo the arrowed screws to remove the carb box. As usual, leave the oil injector alone unless it requires attention.

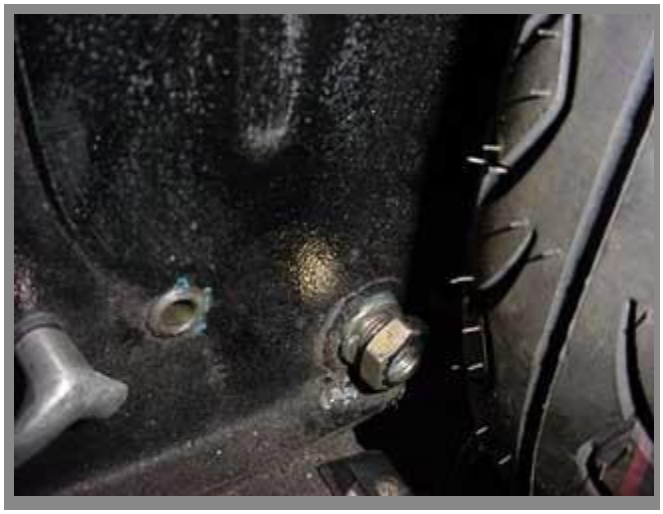


Step 11

Remove the clutch cable by removing the little 7mm nipple on the end of the cable. Pull the inner and outer clear of the engine.

Step 12

Remove the rear shock bolt. The bolt uses two different sized wrenches as pictured. remove the fasterners and drive the bolt out with a hammer if neccessary.



Step 13

Remove the 22mm nut from the main engine bolt. Get a friend to catch the engine as you drive out the bolt with a punch and hammer. Removing the spare tire will give you room to drive the bolt. Pull the engine away from the bike with the exhaust attached.

Step 14
Remove the 17mm exhaust nut to loosen the expansion box.

Step 15

Use a large chisel between the lip of the exhaust manifold and the cylinder to lever the the exhaust away from the engine. Depending on the amount of rust on the exhaust, you may need a hammer to get enough force to lever it away.

Congratulations, you successfully dropped the engine. You can now continue to repair the engine components. But not before food :)!!! To put the engine back in, it is as simple as reversing the instructions. I ran into a bit of trouble with worn cables reassembling my Vespa, so make sure to have spares.

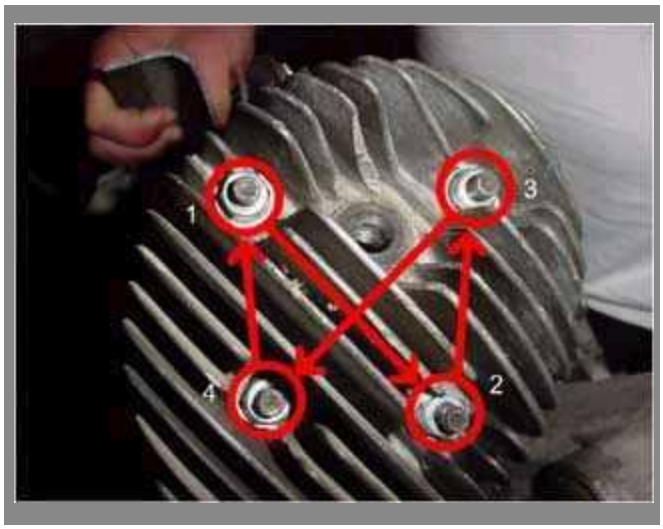
Splitting the Engine Case

Virtually every Vespa motor uses a split case system with a separate cover for the clutch housing. In order to repair the engine's internal components, you must split the cases by removing parts in order. Prior to splitting the case you should always drop the engine out of the frame, so you are comfortable and have access to all sides of the engine. The cases house mostly gearbox components, bearings and seals as well as the crankshaft and kickstart. If you are having problems with these components it is recommended that you buy all of the components in the list below along with the parts you suspect are worn. The cruciform is the most common problem on a Vespa and can be remedied with ease once the cases are apart. Work slowly and in a clean environment for best results. Do not work outside if at all possible, for this will often cause rushed repairs. Wear work clothes that you are not interested in keeping as the engine is usually oily and dirty from road grime. if at all possible, remove loose road dirt from the cases before opening to avoid contamination of the engine.

Tools & Parts Needed
Flywheel Puller (Available at scooter shops)
A Small Punch
Assembly Grease (Thick, high-temperature grease)
Socket Set (7-22mm)
Spanner set (7-22mm)
Long Handled Screwdriver Set
Spark Plug Wrench
Disposeable Shop Towels
A can of Carb Cleaner
A can of WD-40
Split Pin for Rear hub
Metal Hammer
Visegrips
Needlenose pliers
A length of pipe larger than the diameter the handle of your socket driver
A Large Chisel (see below)
A large bag and electrical tape
A Clutch Cable inner
A Rear Brake Cable Inner

Buy the following parts at your discretion
Set of Woodruff Keys (Flywheel and Clutch side)
Rear brake Shoes
Gaskets: Case gasket, Air Box to Case gasket, Selector Box Gasket, Clutch Cover O-Ring, Cylinder to Base Gasket, Oil Drain Plug Gasket.
Seals: Flywheel Side Seal, Clutch Side Seal, Rear hub Seal

Disassembly



Step 1

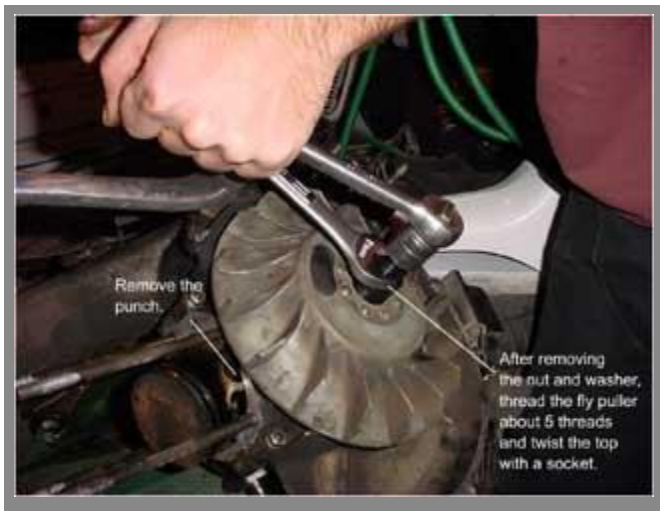
Remove the nuts by loosening them slowly in this order. Do a quarter turn, go to the next, quarter turn, next, quarter turn, next, etc. until the nuts are removed. This will take a while, but you risk bending the aluminum head if you don't do them in small steps and in order. The same is true for tightening. Carefully collect the hardware and remove the cylinder head.

Step 2

Remove the Cylinder Head; then remove the Cylinder Barrel, exposing the piston. Note imperfections on the piston. For example, the large black band directly below the piston rings suggests worn piston rings. See below for tips on repair. Prise the alloy cylinder seal off the edge of the engine case.

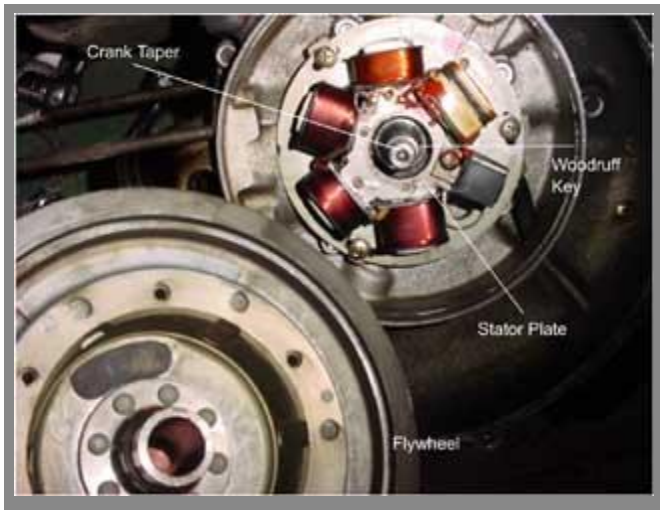
Step 3

Place a small metal punch lengthwise through wrist pin ensuring both sides touch the edges of the case. Rotate the flywheel until it is held tight by the punch. Using a socket, remove the flywheel nut. You may need more leverage so use a pipe length on the end of a socket. It is not adviseable to use a hammer.



Step 4

Remove the punch from the piston. Lightly oil the flywheel puller threads and thread the tool into the center of the flywheel. Get about 5 or 6 threads of the tool into the flywheel. Using a spanner and a socket, tighten with the socket and anchor with the spanner (pictured).



Step 5

The flywheel will pull away from the crank taper revealing the stator, taper and woodruff key. These are the key timing components of the engine.

Step 6

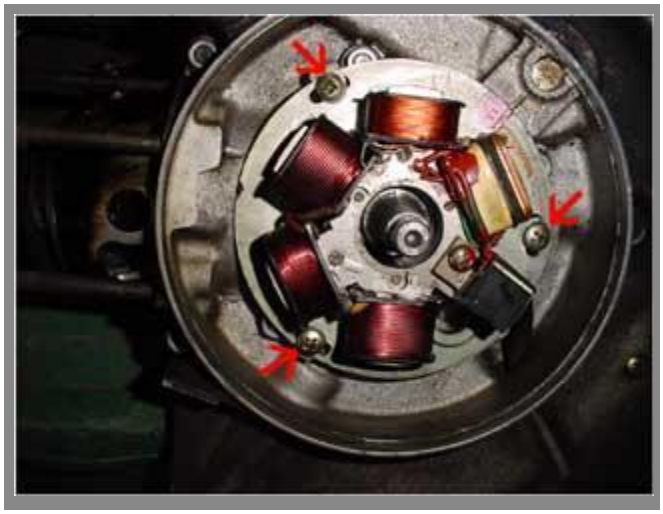
Pull the half-moon shaped woodruff key and inspect it for shearing (deep line in the metal), if there is no scoring then you may reuse it. Look for cold solder joints on the stator (disconnected or cracked solder joints) and repair them as neccessary. The picture depicts an example of a good solder joint.

Step 7

Though most P-series Vespas come with timing marks cast into the engine, it is a good idea to make a thinner line with a screwdriver, so you can get it dead on. A screwdriver and a hammer tap on the edge of the stator plate and case will quickly mark and accurate stock point.

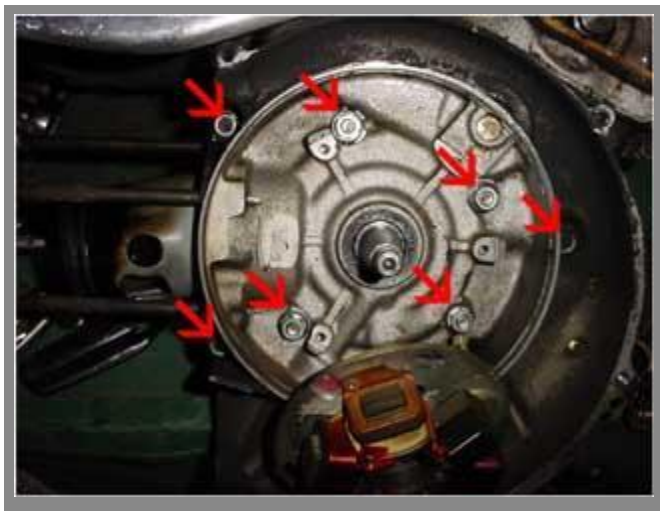
Step 8

Here is the result. When realigning the stator, use this new mark as a base timing point.



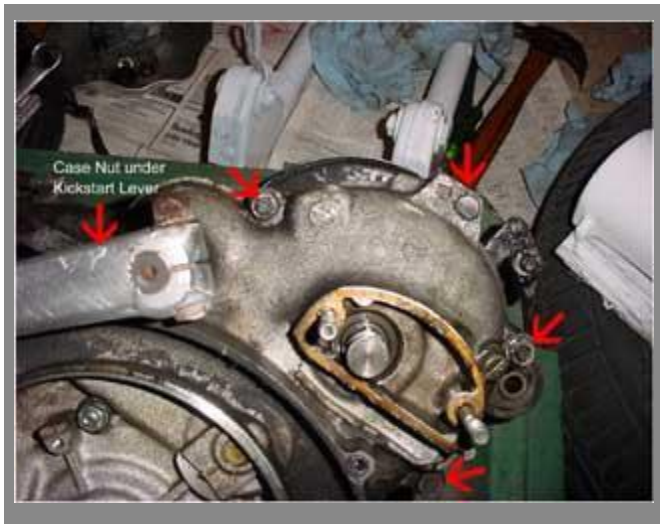
Step 9

Remove the arrowed screws to get behind the stator plate. These screws strip easily, so push down on the screwdriver and use the proper sized driver. If you strip a screw, a pair of Visegrips will loosen it. Always replace stripped screws.



Step 10

Carefully dangle the stator from the case. NEVER ROLL THE CASE ONTO THE STATOR. There are a number of case screws to loosen (arrowed). Loosen them and store them somewhere safe. Many screws have a complimenting stud that will fall out as they are removed.

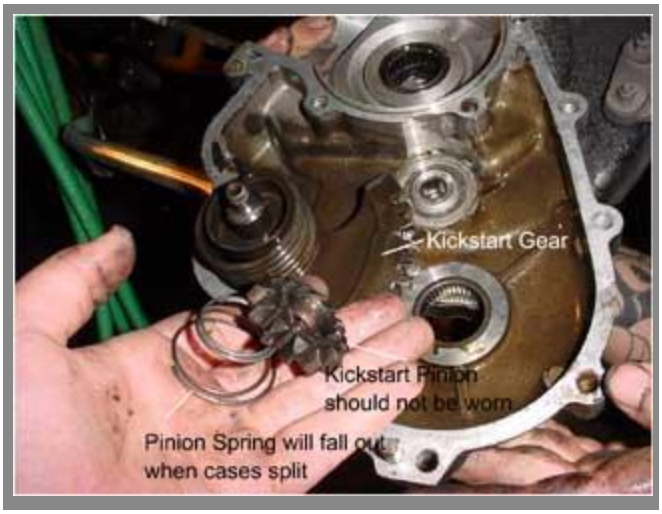


Step 11

There are a number of case screws to loosen (arrowed). Loosen them and store them somewhere safe. Many screws have a complimenting stud that will fall out as they are removed. The stud and nut under the flywheel is called the long case stud. It tends to rust and seize. If yours is siezed, order a new one from a scooter shop.

Step 12

With all the nuts removed you are ready to split the cases. Tap the point next to the oil plug (pictured) with a rubber mallet and a piece of wood and the cases will nudge apart. DO NOT move the kickstart lever. You should be able to simply pull away the case to reveal the gears. The picture shown depicts a metal hammer being used. After great debate, I have decided to amend this section. *****Ignore the metal hammer an use a rubber one instead. You risk damaging the cases with a metal hammer.*****

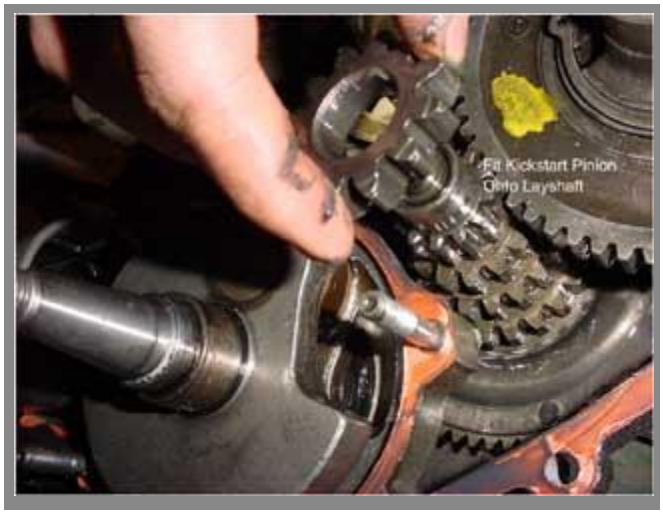


Step 13

A spring and the kickstart pinion will usually fall out of the case. collect them and inspect the pinion for wear. If any teeth are missing, renew the gear. The one pictured is not worn.

Reassembly

Step 1
Pull the old case gasket and rub remenants away with a wire brush. Rub a ring of assembly grease around the case edge and replace the gasket with a new one. If the old gasket is not torn, it may be reused in a pinch. Always renew the case gasket while the engine is open.



Step 15

Replace the kickstart pinion onto the layshaft with the teeth facing down. (pictured)

Step 16

Kickstart pinion Spring should be retained with a large glob of assembly grease, now flip the case and place it onto the other case half. Watch that the spring does not fall. press the cases together, moving the kickstart lever to mesh the gears. Tap the cases on any flat spot to push them together. Now follow the disassembly instructions to finish the job.

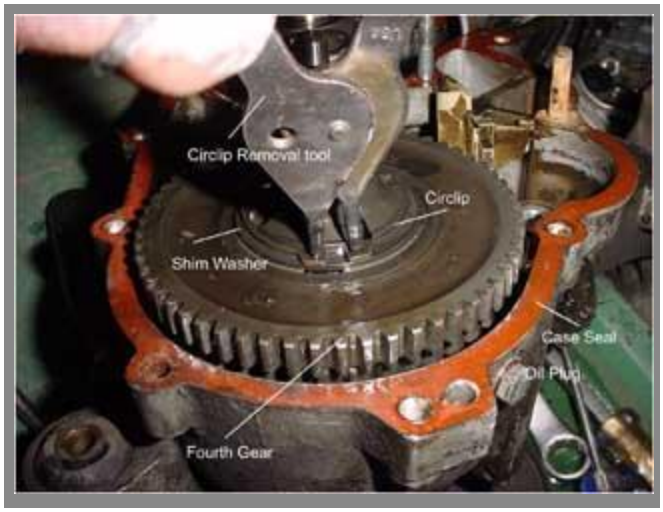
So now you're finished cracking the cases (use the reassembly instructions above after you have repaired the problem). You can return to the engine repair section and select a topic related to the inside of the cases. Above, I talked about blowback marks on the piston. These marks show that combusting gas is escaping past the piston. This is generally not a huge problem, but it should be remedied. To fix this situation you should take the cylinder to a machine shop to be honed and the piston rings should be renewed. The rings will just continue to deteriorate and a loss of power will result. The piston showed no signs of heat seizing, but it is generally identifiable by oval shaped scratches up and down the piston head. If you note such marks, this represents the engine overheating or the cylinder out of tolerance. Replace the seals, have a shop hone the inside barrel and renew the rings to prevent further siezes. You should also inspect your carb and timing if these marks are observed. Consult a scooter shop for further assistance.

Cruciform Renewal

Ever riding up a hill and your bike surges or slips out of gear? This is often the fault of a component in the engine called the Cruciform (or spider). The cruciform is a small cross-shaped alloy part used to select gears. It works by fitting into square cut outs in the gears themselves. This is a high wear part. Since there is almost no buffering between the gears, this part receives damage with almost every shift. Sloppy shifting will expediate its demise. Luckily, this piece will not hurt the steel gears when it slips. Unfortunately, it is buried deep within the engine. To get at it, start by dropping the engine, then split the cases and follow the procedure below. Before you attempt this repair, check that your gear selector box does not have any side to side play. Sometimes this play will make the bike jump out of gear. Replace the gear selector box components and try to make the bike jump. If it doesn't jump, you have solved the problem. Otherwise change the cruciform and inspect the gear shims.

Tools & Parts Needed
Cruciform
Circlip Removal Tool
Red Grease Pencil
2 Feeler Guage Tools
Multi Screwdriver
Spark Plug Wrench
Disposeable Shop Towels
A can of Carb Cleaner
A Tube of Anti-Sieze Lubricant
13mm and 11mm Deep Socket
Torque Wrench (Absolutely neccessary, DO NOT perform without this item)
Plastic Bondo (Body Filler) Scraper
Plastic "Wire" Brush
Tub of All-Purpose / Bearing Grease ("Green Goop")

Procedure



Step 1

First check the play in the gears. The gears should remain tight when jostled. To see a bad shim washer click here. More information about shim washers can be found below Using the circlip tool, remove the circlip around the rear axle. This will allow for the shim washer and the gears to be removed.

Step 2

Remove the shim washers and the gears. Marking the gears with a grease pencil will identify which side faces up when reassembling.

Step 3

You can now remove the selector rod, the rod washer and the cruciform. This shaft uses a left hand thread, meaning everything is backwards. To loosen turn clockwise, to tighten turn counter-clockwise.

Step 4

Sinch the lighting was pretty bad, we took the rear axle out of the engine to give you a better view of this part. You don't have to do this. For all this work, you can now treat yourself to a pickle. We certainly did :))

Step 5

Here's the selector rod. It's a chunk of metal with a small washer on the end. The threaded piece threads into the cruciform.

Step 6

Turn the cruciform by hand until it is parallel with the rear axle slot. You can now just push the cruciform out through the side of the slot. place the new cruciform into the slot. The Cruciform will be fitted with the bend in the legs facing the rear wheel.

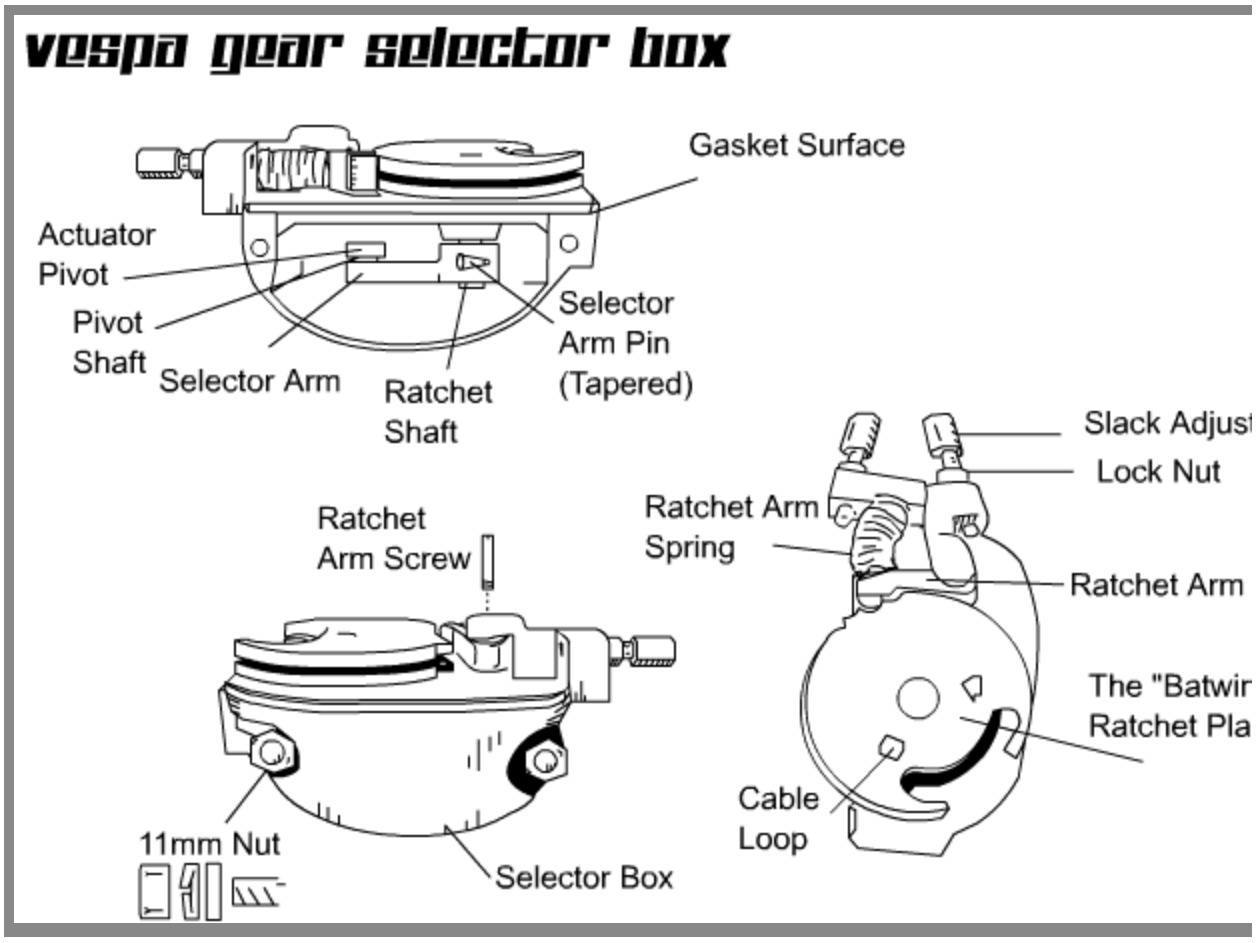
Step 7

This picture illustrates the damage caused to the cruciform by shifting between the gears. Always use Piaggio cruciforms when replacing the old one. The cheaper parts tend to wear faster and do not have as pronounced of a bend making them hard to fit correctly.

The shim washer is incredibly important to the operation of the gears. You should make sure that this item is sound before closing the engine. To test the space use two feeler guage tools and place them under the shim washer. The allowable slack limit is 0.50mm (0.020 in). Oversizes are: Stock - 2.05mm (0.081in), 1st oversize - 2.20mm (0.087in), 2nd oversize - 2.35mm (0.093in), 3rd oversize - 2.50mm (0.098in), 4th oversize 2.65mm (0.104in). Once everything is in good condition, replace all the gears, the washer and the circlip. Then continue to reassemble the engine cases or continue to fix problems in the engine.

Gear Selector Box Work

The Vespa gearbox has not changed in a very, very long time so this information should be helpful to most every Vespa owner. The Selector box rarely needs attention; however, it is an integral part of the transmission and can break down just like any other moving part. The box selects the current gear by pulling a rod back (you can see this rod in the cruciform replacement area) and forth through the transmission. if this box fails, you will be unable to select gears until the problem is fixed. Below I will outline some procedures for inspecting and setting the gear selector box.



Setting the Cables

One of the more tricky cable installations on a Vespa would have to be the gear selector cables. if the cables do not appear to be broken, but the shifting is weird or not working, carefully inspect the gearbox for damage (namely the selector arm as they may snap, there are more details on this below). I have found a fairly good way to approach this task. You will need a 7 and an 8 mm spanner, two pairs of Visegrips (one needlenose preferrably), a set of cables and a friend to help. If only one cable is broken, I find it easier to just start fresh and do both cables while I'm at it. There is a single screw at the bottom of the flywheel that hold the selector box cover onto the engine. Undo this screw and pull the cover aside to reveal the Selector Box Parts. Tighten the slack adjusters so they protrude into the selector box.

Once you are into the gearbox begin by undoing the cable nipples using two small spanners. Pull the nipples clear of the box and set them aside. To replace the cables on a P series you will have to open the

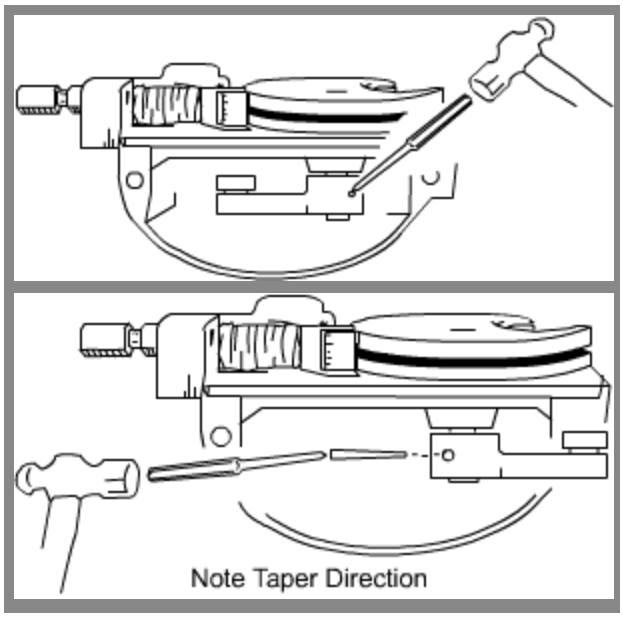
headset. To open the headset, undo the 4 screws on the bottom of the headset and lift it as much as you can without yanking on it. push the speedometer cable (large cable right near the front wheel) toward the rear of the bike and the headset cover will pop straight up. you should now be able to see the inside of the headset. Apply a peice of duct tape to the speedometer cable, just below the locking ring (the thing attached to the speedometer under the headset). Unscrew the locking ring and allow it to rest on the duct tape (that way it won't fall into the fork tube). The headset will still be retained by wires. you can usually flip the headset back and work unimpeded, but if you know where everything goes, you may choose to unhook all of the little wires. There is a disc on the inside of the headset attached to the end of the gear selector handlebar. there should be two cables in this disc. These cables are the gear selector cables and they run down to the gear box. To renew these cables, carefully prise them from their seating in the disc and pull the cable straight out. Once one cable is out, replace it by feeding it down the same outer cable and then move onto the next, so they don't get out of order at the gearbox. Once both cables are seated in the disc, set the handlebar so the dots line up. Don't bother closing the headset yet.

Go back down to the gearbox. Have a friend hold the handlebar so the dots line up. Begin by pushing the nipples onto the cables. Grab both cables with a Visegrips and pull on them fairly hard. While they're tight, get your friend to move the handlebar up and down. This will quickly take up all the slack in the cables. Once you're done taking up slack, get your friend to set it back to the two dots. Turn the batwing to neutral by hand while gently rolling the bike back and forth. Neutral can be identified as a raised area between 1st (closest to the engine) and 2nd on the batwing (the bike will roll smoothly when in neutral. Get the needlenose visegrips and push the nose of the pliers up against the cable nipple as hard as possible while still pulling on the cable with the other set of Visegrips. The nipple should slide into the batwing slot. Once it's firmly pressed into the slot, clamp the needlenose visegrips onto the cable so that they continue to press into the back of the nipple. Tighten the nipple using the wrenches. Do the same procedure for the other cable.

The cables should now be set. The acid test is to roll the bike back and forth about 1m each direction and try to change gears. If the bike makes it to first and fourth gear, you're done. If it doesn't, try the whole prodecure again until it is right. You shouldn't have to use the slack adjusters. Once you finish, reassemble the headset by reversing the order of disassembly. Once you're good at this procedure, it takes about 15 minutes. At first it will take hours of cursing and hate - so be patient. Usually when you're about to give up, it suddenly works.

Inspecting and repairing the Selector Arm

The selector arm is a small cast piece of metal that forms the physical connection to the gear selector rod inside the engine. Since this part is under a lot of stress it may be vulnerable to cracking off due to lack of gearbox oil, sudden stress from the selector rod (usually from jumping out of gear) and bad casting. A key sign that this may be a problem is if the handlebar moves far past 1st gear without engaging a gear. If you notice this behaviour kill the engine and undo the 11mm bolts that hold the gearbox to the engine. gently pull the gearbox clear of the engine (there is a paper gasket between the selector box and the engine case). If indeed the selector arm has broken and you are in the middle of no where, try to find some brass or aluminum wire and make multiple wraps around the selector arm and ratchet shaft as an emergency repair. Shift as little as possible and try to get safely home. The selector arm usually snaps at the ring around the ratchet shaft and it can only be repaired only by ordering a whole new part. If you have a worn cruciform that jumps out of gear, you are at risk for this piece snapping off.



When ordering new parts, request a selector arm and a new tapered pin, as the pin is likely to be difficult to refit. you will need a ballpeine hammer and a small punch suited to the size of the hole. You may also need a reamer (taper tool) suitable to the size of the hole. Start by removing the cabling and get the box into a well lit area. On a wooden surface, tap out the pin as per the top picture. It will fall out completely with only a small bit of force. Crank the selector arm far past the fourth gear position as in the diagram. with the pin removed, slowly pull up on the batwing and place the new ratchet arm on the shaft. Line up the holes and punch the new pin back into place as shown in the bottom diagram. The pin should go all the way in. If it stops, adjust the position of the selector arm on the ratchet shaft and try again. If you cannot get it in, use a small reamer to redefine the taper on the new part. Once you have reamed the hole

a small amount, refit the pin and try to bang it in. keep adjusting the taper until it will allow the pin to fit snugly in the hole. Once you are done, refit the selctor box and cabling (see above for instructions). Drain and fill your gearbox and replace the gasket if neccessary.

Ratchet System Troubleshooting

The ratchet system should rarely need attention but problems can arise if the spring is deformed or the roller pops out of the ratchet arm. To remedy this problem, simply order new parts and replace the old ones. The ratchet arm is held in by a small flat headed screw. Uncrew the screw carefully and catch the spring if it goes flying. Replace any malfuntioning part and reverse the order of disassembly to fix the problem. The batwing is force fit to a shaft that is precisely positioned. if there is any wear to the batwing or ratchet shaft, replace both items. you will have to remove the small tapered pin on the selector arm to effect repairs to this item.

Exhaust System Maintenance

Many largeframe vespas have ratty, rusty pipes that have been collecting years of carbon deposits and scraping on the ground. Eventually, the exhaust system will need some TLC. My exhaust recently cracked at the weld, so I thought I would show the meaty insides of a stock Vespa exhaust before I try to reweld the thing. The stock exhaust only consists of a few simple parts.

With the exhaust broken apart, we can identify a u-bend pipe that goes from the exhaust stub on the cylinder to a baffle (in this case, a fluted cylinder). There is a convexed piece of metal spot welded to the end of the baffle to direct the charge out the fluted sides or the baffle rather than let it flow straight through. Depending on how these baffles are made, there will be a difference in how the engine operates at certain rev ranges. This is probably as tuned as a stock exhaust get. If the piece of metal falls out of the baffle, it will make a tonne of noise inside the expansion box and may cause a slight loss of performance. If you shake the exhaust and hear a pronounced rattling, the spot weld holding the blocker has likely failed.

The inside of the expansion box is just an area for exhaust gases to occupy during engine cycles. The area in this box forms an air column that reacts to the various changes in pressure caused by the operation of the engine. On the right hand side is a piece of sheet metal that extends from the top of the expansion box to the bottom. The piece of metal has 4 evenly spaced holes to promote the escape of waste gases. The gases enter a smaller chamber behind the wall and escape through the tailpipe to the outside.

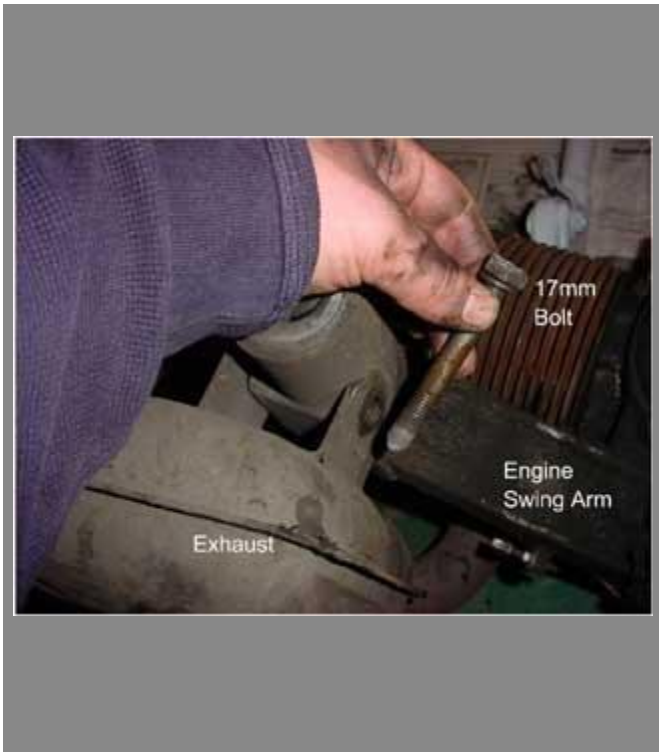
To restore the exhaust, you need to get a carbon dissolving agent like sodium hydroxide (drain cleaner) and pour it, unconcentrated, into the exhaust. The longer it sits the more of the build up will disappear. There is nothing to really come loose as you can see, but don't stick a coathanger down the exhaust, because you may damage it more than help it. A liquid cleaner should be sufficient. There is a wire mesh that lines the expansion box. I have no idea why they put this in other than to stop heat buildup, but avoid trying to decoke the exhaust using a torch as it may damage this mesh and cause some problems.

Tools & Parts Needed
Bottle of Drano Extreme (get concentrated sodium hydroxide)
Metal hammer and a 7/8" cold chisel.
1200F Manifold Paint
"VIM" bathtub cleaner
wrench set (13mm 14mm and 17mm)

Procedure

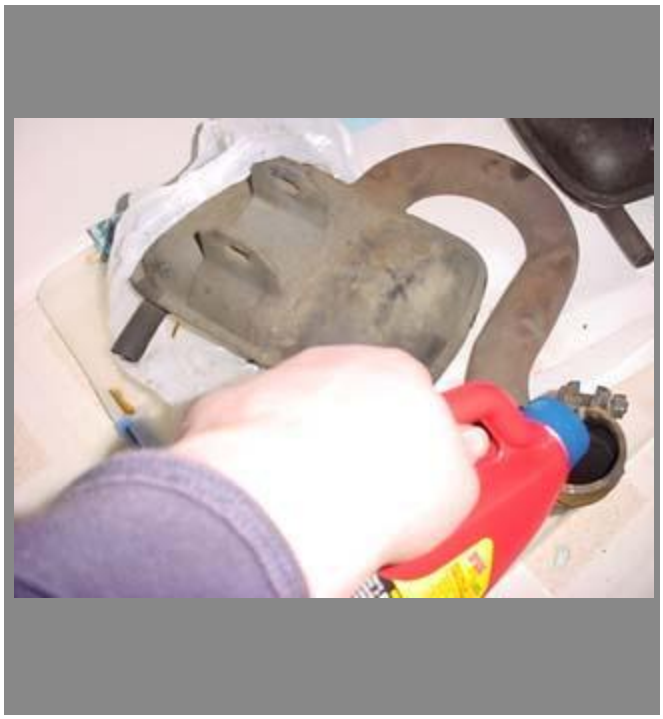
Step 1

Start by getting the bike up on blocks. Take the wheel off by loosening the 5 - 13mm nuts on the hub. Pull the tire away and let the bike sit on blocks alone.



Step 2

undo the 17mm bolt behind the tire, you may have to remove the spare tire as well for easy access. Undo the 13mm (or 14mm) bolt on the exhaust ubend (right below the cylinder behind the kickstart lever). Once you get the 17mm and 13/14mm bolts out, take a hammer and a DULL (make it dull by scraping it on some cement for a few minutes) cold chisel and put the chisel between the cylinder shroud and the exhaust clamp (the clamp where the 13/14mm bolt was). Start banging on it until the exhaust pops off. Take care not to gouge any of the components.



Step 3

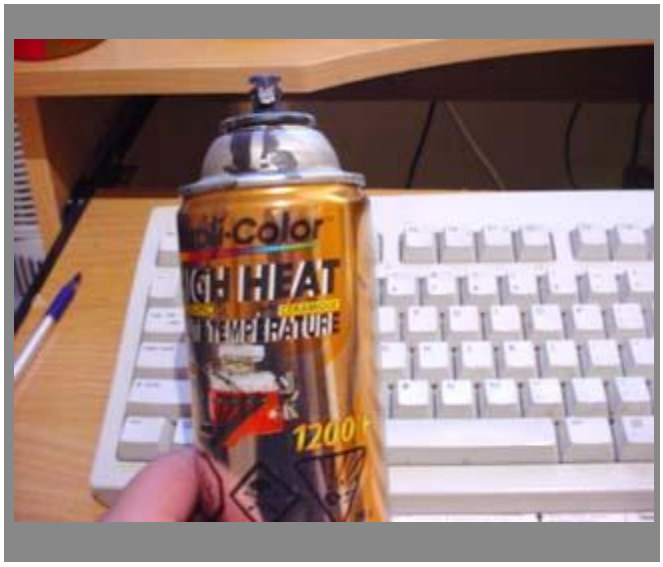
Take the exhaust away and leave the bike on blocks. You may want to block the tailpipe (though it shouldn't be that necessary). Put the exhaust on a plastic surface and pour a whole bottle of drano down its throat. DO NOT PUT OTHER STUFF IN THERE! YOU'LL NEVER GET IT OUT! Plug it up, put on some gloves and glasses, and slosh it around a bit. Let stand for three hours. DRANO STAINS REALLY BAD (LIKE BLEACH) KEEP IT AWAY FROM CLOTHING AND CARPETING AS WELL AS KIDS!

Step 2

Put on gloves and glasses and carefully move the exhaust to the bathtub. Use HOT water and rinse the drano out by saturating the pipe with water. Don't let the exhaust scrape your tub. shake it HARD to get more and more big chunks out. the most chunky stuff will come out when you allow the twater to exit from the ubend side.

Step 3

So you don't get killed by your significant other or 'rents, use some VIM to wash the crud from the tub. it will take about 15 minutes to get it all off the tub. Use some plastic bags in the tub to prevent the water from travelling all over the tub. It will make cleanup faster.



Step 4

If you have the time, take the exhaust to a high speed wire brushing machine to fight rust better. If you don't have the time, get the loose crap off with a normal wire brush before painting. Use some high teperature (1200F) manifold paint on the outside. The stuff stinks real bad, but the smell goes away as you ride. Once it sets up, put the exhaust back on the bike and RIDE!

Complete Engine Teardown

This is an in depth method to a nut and bolt restoration of the motor. Due to the huge number of photos I have decided not to annotate the images themselves except where the material may be unclear. You can also click on the images themselves for a closer look. You will need a good set of tools and a little help from a friend every once in a while (especially if you don't have an engine stand :D). Before you start, it may be a good idea to run the line clear of gas and clamp it with a good pipe clamp to ensure that it doesn't leak during the process. Unhook your battery ground otherwise you'll almost certainly blow a fuse.

Tools & Parts Needed
Socket Set (7-22mm)
Spanner Wrench set (7-22mm)
Long Handled Screwdriver Set (#1,2,3 Philips and #2 flat head)

Spark Plug Wrench
Disposable Shop Towels
A can of Carb Cleaner
A can of WD-40
A good grease solvent
Rubber Face Mallet
A Metal Hammer
A number of pairs of Visegrips
Needlenose pliers
A set of circlip pliers
A Large Chisel (see below)
A Clutch nut remover
A Flywheel Puller
Various bearing extractors and punches(if necessary)
A good strong Punch
An oil container
A set of feeler guages (a 20 pack does well)
A clutch compressor
Some milk crates to set the bike on
A gudgeon pin extractor

Procedure

Undo the oil drain plug screw with a spanner and allow oil to drain out of the bike. There is not much oil in the gearbox, so a 10" pieplate should sufficiently hold the oil. Drain the oil into a 4L juice bottle using a funnel and take it to the nearest recycling station when it gets full.

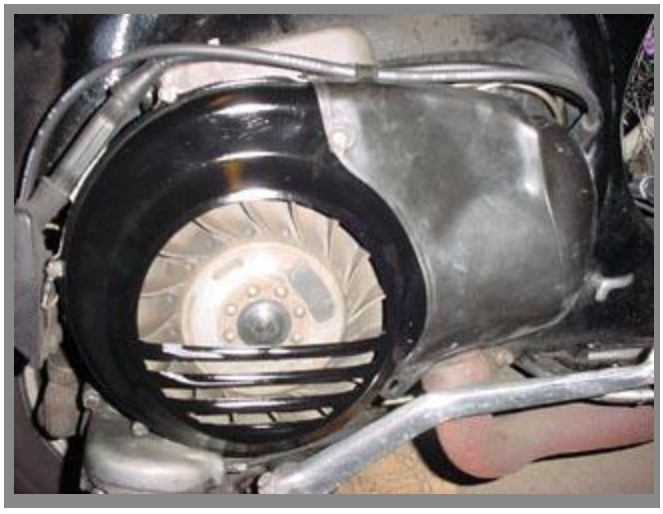
Remove the rear hub dust cover and pull the cotter pin out of the large castle nut. Using a 22mm socket, loosen the Hub nut. If the nut doesn't come loose, try a breaker bar or extend your socket using a piece of pipe over the handle.

With the hub loosened, place the bike on secure crates for the rest of the procedure.

Once the bike is secure, remove the hub nut and washer and pull the wheel away from the bike. You may want to put a bag around the brake pads in case oil happens to spill from the motor. Make sure to lay some paper or oil absorbent material beneath the motor during this procedure.

Open the junction box and disconnect all of the wires inside, while noting color matching. There is one green wire that travels past the junction box into the ignition box below.

Disconnect all of the wires to the ignition box and pull the Spark plug cap off of the plug. Make sure to keep track of all the rubber bits and if they are excessively worn, replace them.

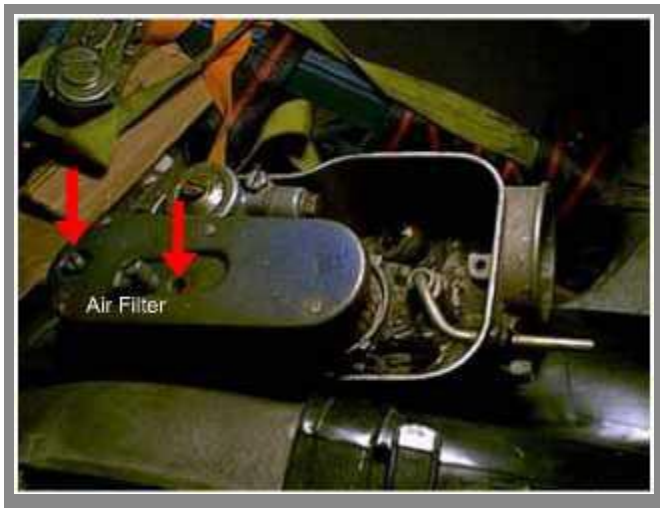


Unscrew all of the engine and fan shroud screws and pull them off of the engine. Carefully unhook any of the electrical cables attached to them.

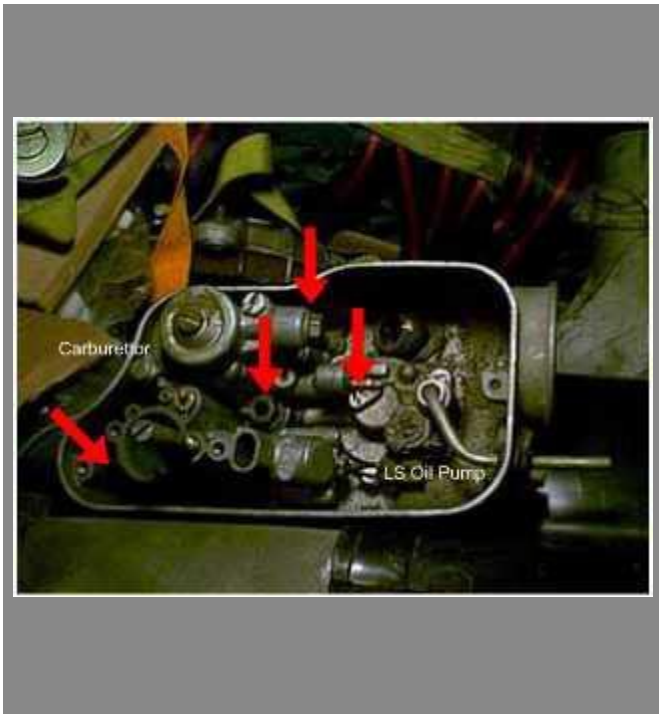
Disconnect the rear brake cable by unscrewing the harness on the actuator arm of the brake. you will likely need a socket to do this.

Remove the two 11mm nuts that retain the gear selector box. Use the handlebar to "shift" to 4th gear and just a little beyond. the selector box will pop off. take care not to damage the gasket beneath the box otherwise you will have to add it to your parts list.

Remove the carburetor air box top by removing the two arrowed screws.



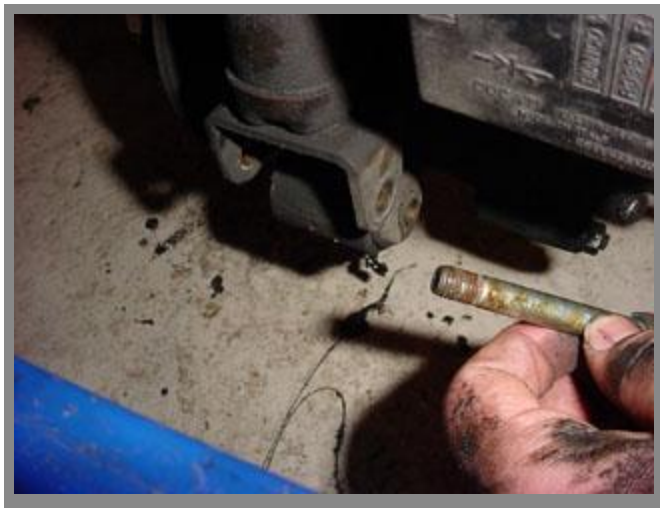
Remove the air filter by removing the two arrowed screws.



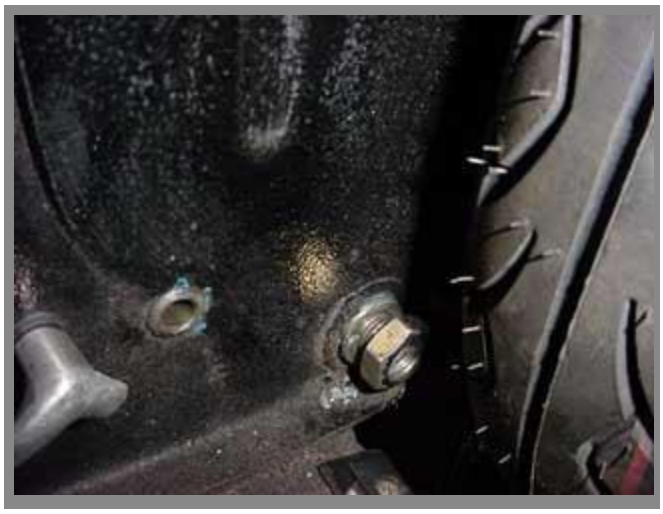
Unhook the choke cable (the thin wire in the center of the carb) from the choke lever. Unscrew the gas line union nut using a 10mm socket. Loosen any hose clamps that may be applied to hold the line to the union banjo and pull the banjo shaped union out of the fuel line. Loosen the two 11mm bolts that hold the carb to the engine using a deep socket or extended wrench. Take care not to lose fasteners in the carburetor. If you have an injected model, do not mess with the injector unless it has stopped working. Once everything is loose, pull the carburetor body straight up and out of the air box.

Underneath the carb to air box gasket is a flat head screw that holds the carb box to the motor. simply unscrew the screw to detach the air box. Once that's off, pull the injector gear (if applicable) from the motor. The gear should be clean and free of scratches.

Remove the cable nipple that holds the clutch cable on. Pull both the clutch cable and rear brake cable free from their respective slack adjusters.



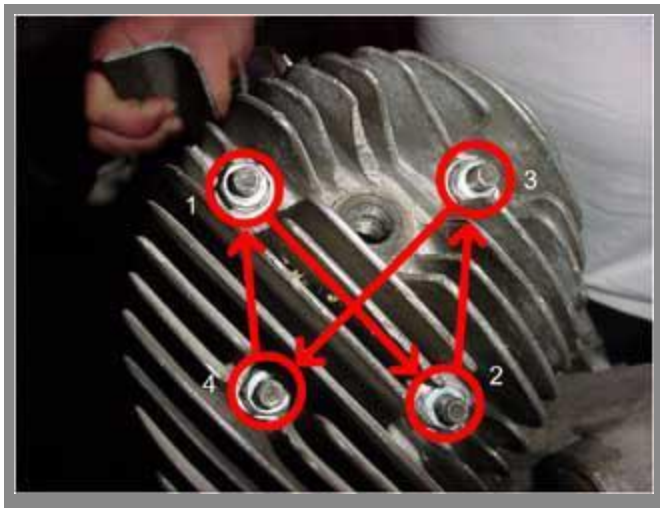
Remove the rear shock bolt and put it aside. The engine may drop a bit, so take precautions to make sure the bike is stable.



Clamp a pair of Visegrips to the bolt head of the engine mounting bolt and allow them to catch on some part of the frame. Using a 22mm socket, loosen the nut on the main engine bolt. Once it is loose, collect the nut and lockwasher and bang the bolt through with a hammer and a drift. Be prepared to catch the motor if it falls.

Undo the 17mm Exhaust box bolt. collect the lockwasher and bolt and put them aside.

Loosen the exhaust clamp and see if you can wiggle the exhaust off the exhaust stub. If you can't budge it (which is often the case), take a large chisel to the side and lever it off with a few sharp blows with a hammer.



Now remove the cylinder head. Loosen all the bolts a 1/4 turn at a time in the following order. The head is quit soft metal and easy to warp, so take your time and loosen the nuts properly. Unscrew the sparkplug once you're done getting the cylinder nuts and washers off. Finally, Pull the head off.

Next, pull the cylinder off of the studs and place it aside. Use a smear of oil on the cylinder wall to prohibit rust. gently pry the alloy seal off of the engine case.

Remove the two piston circlips and put them aside.

Drive the gudgeon pin through the piston using a clean 3/8" socket extension or a gudgeon pin extractor tool. Remove the piston and the small end bearing. note: you can see a piston ring locator pin in the center of the ring gap.

Push the piston rings apart with your thumbs and push them over top of the crown. They will come off. Inspect the piston for scuff marks and make sure the pin locators are in position.

Here are most of the parts of the piston assembly. The only thing not show in the picture is the small end caged bearing. Note how scratched up the piston skirt is. It would be wise to replace a piston that is that scuffed up. If your piston looks like this, you will have to oversize your cylinder and use a new oversized piston.

Let us now move to the clutch. To get at the clutch you will need to remove the clutch cover. There are 3 10mm bolts around the clutch cover and another large 17mm bolt to the right. Leave the 17mm bolt alone for now, as it holds in part of the gearing.

This is a shot of the inside of the clutch cover. this assembly consists of a few seals and an arm that puts pressure on the clutch. The part to watch for is the little brass push out bearing in the center of the cover assembly. It can drop out and into the motor.

To remove the clutch, you must first take off the pressure plate. There is a little piece of wire holding in the plate. All you have to do is push the wire towards the center with a screwdriver and the plate will relase. NEVER BEND THE WIRE!

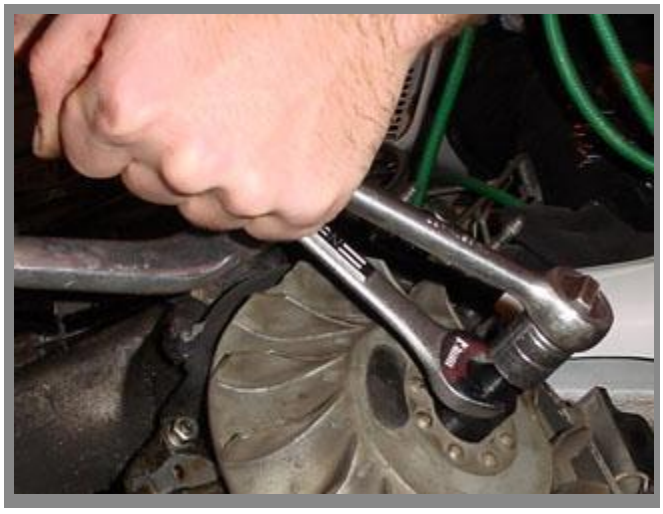
Underneath the pressure plate you'll find the nut that holds the clutch onto the crank. You'll have to pry back the little teeth on the lockwasher in order to loosen the clutch.

This is a clutch nut removal tool, a specialized tool for Vespas. You need to buy this tool in order to remove the clutch. There are other ways of getting it off, but we couldn't get them to work.

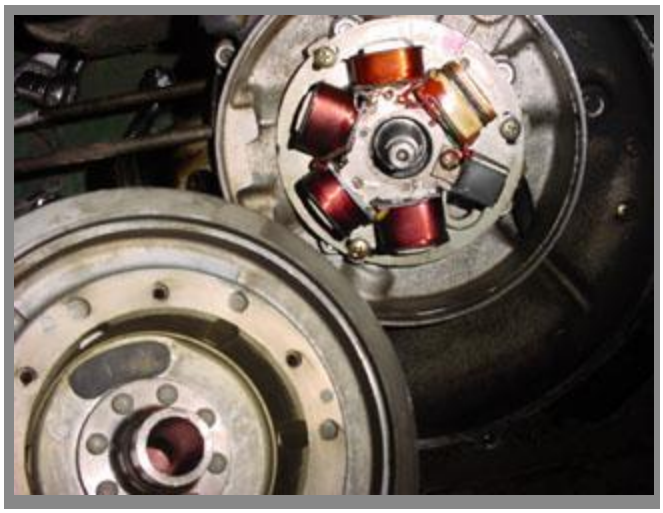
You will also need a clutch holding tool. This is the way to do it right. it saves a lot of grief over doing it other ways and preserves the clutch nut teeth much better. If you are hard up for time, put a round tool through the small end of the connecting rod. with the apparatus in place, undo the clutch center nut.

Often the clutch will be loose enough so it will come off when it is levered with two screwdrivers. The crankshaft is not tapered so it shouldn't be a wrestling match. However, the woodruff keys sometimes get sheared, making it extremely difficult to remove If you can't get it out now we'll deal with it later in the process. Otherwise pull it out and remove the woodruff key.

Before unscrewing the nut on the flywheel, you will have to lock the flywheel. This is the hard part to do right. Generally I lock the crankshaft by sticking a round tool through the small end of the conrod. You could also put a tool between the flywheel fins or buy a rare flywheel holder tool. Once it's locked, pull the dust cover from the flywheel and unscrew the nut underneath.



Take the special flywheel pulling tool and thread it about 5 or 6 good turns into the flywheel. Then, using two wrenches, slowly turn the center of the tool tighter and hold the outside of the tool steady. Eventually the flywheel will release from the crank and pull away.



Underneath the flywheel is the stator, the electrical generator for your bike. Make sure everything is nice and clean. If you see ratty wires or anything like that, it might be a good idea to replace them. Keep this part of the motor super clean. Remove the woodruff key from the crank taper.

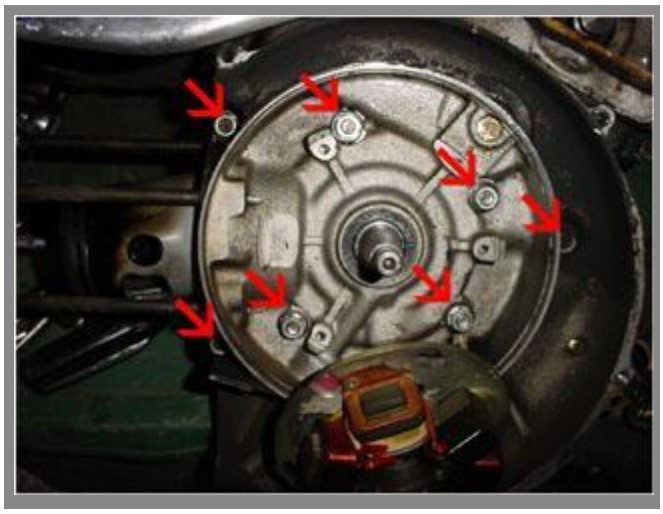
Mark your default timing point by hitting a flat head screwdriver on the case and stator. Careful about using felt markers as gasoline will erase your timing mark and you'll have to re-time the engine.

Undo the three Philips head screws that hold the stator plate to the motor. The stator will then dangle free.

Pull the stator free of the motor and place it somewhere safe. if it needs electrical repairs or wire replacement, do that while you wait for new parts. :)

Sometimes the woodruff keys can be a bitch to get out. this method usually works well. get a small metal punch and position it on the rear of the woodruff key. hit it with a hammer and it will slide forward and eventually pop out. It won't hurt your keyway either! Bonus!

Remove the ignition box from the motor. Almost every motor has a different mounting scheme, so just roll with it :)

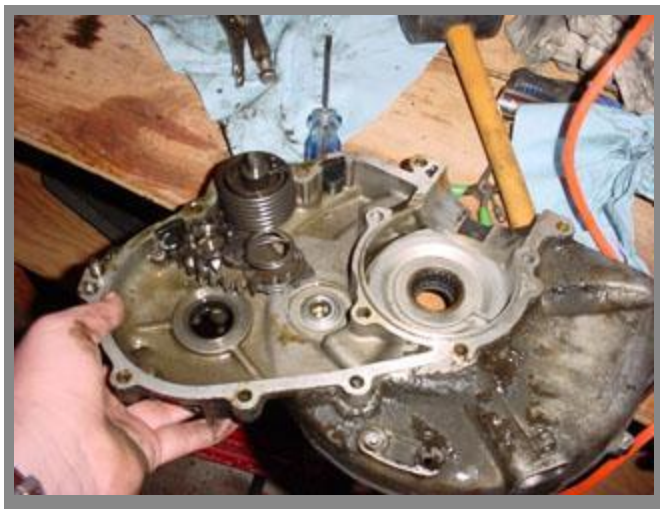


Remove the arrowed bolts. We're about to crack the cases.

Remove the arrowed bolts. Can't you feel the excitement?!

Undo the kickstart lever.

Take a rubber hammer and whack the case a few times while holding the motor flywheel side down. The cases will just peel right apart.



This is the flywheel side of the case. Collect the kickstart gear and the kickstart spring (they're sitting on the kickstart gear in the picture).

Put the flywheel side case aside for now and move to the gears. Check the gearbox float with a feeler gauge. Stick another set of feeler gauges under the opposite side of the measurement point to balance the reading. the float should be 0.15-0.40mm (0.50mm is the extreme limit). If it goes beyond that, you have to buy a bigger gearbox shim. Use your math to get the float down to about 0.30mm float and oversize accordingly.

Remove the gear retainer circlip.

This is the gearbox shim. If you found your float measurements were out of spec, this is the part you will have to oversize. This part hold the gears tight together so they cant rock on the output shaft. If you leave a bad condition, you may cause rapid wear to your gearbox.

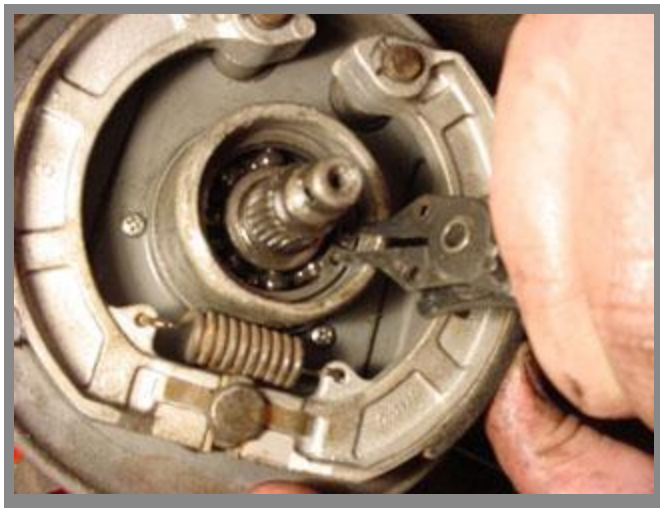
Remove the gears one by one and mark the side facing out with a grease pencil for easy reassembly. Look for extreme wear such as this on the notches. A gear this badly chipped should be replaced, because it will cause quick wear on the shift cross.

With all the gears off, pull the plunger to the extreme outer edge. This part is reverse threaded, so turn the flattened part of the plunger with a 13 mm wrench in a clockwise motion (opposite to normal) to loosen it. Extract the plunger and its spacer washer.

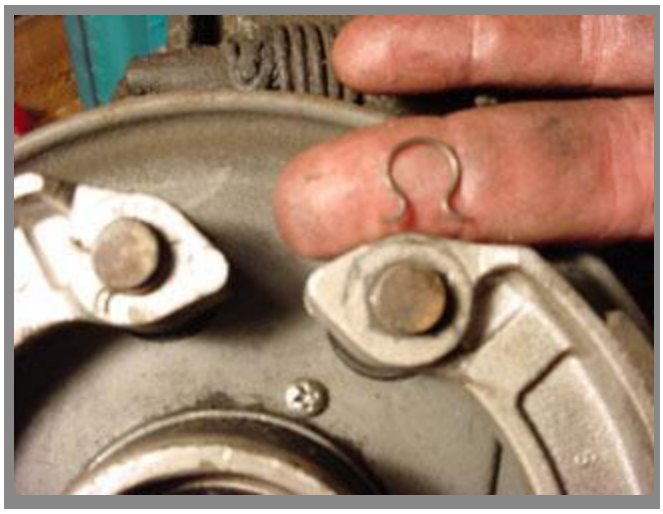
Extract the plunger and its spacer washer.

Turn the cruciform on its side and remove it from the axle housing.

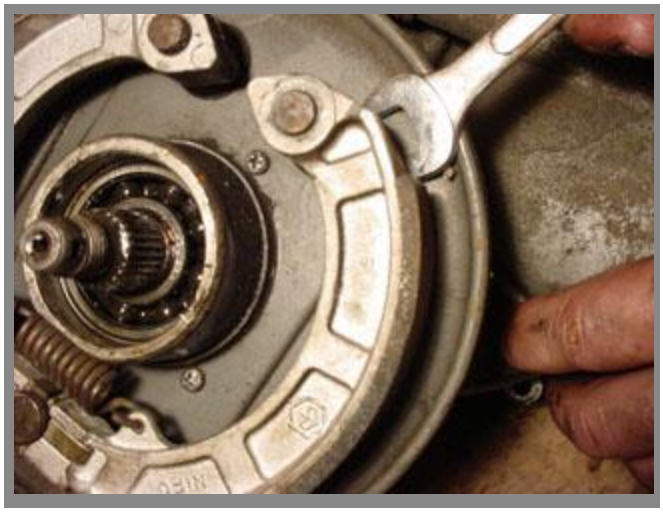
Now go to the hub side of the case and remove the hub seal.



Remove the circlip underneath.



Remove both brake clips by hand or with a pair of pliers. They tend to go flying, so hold a rag over top of them.



Lever the brake shoes off using a wrench and operating the brake cam. The brakes will eventually slide off the cams and collapse.

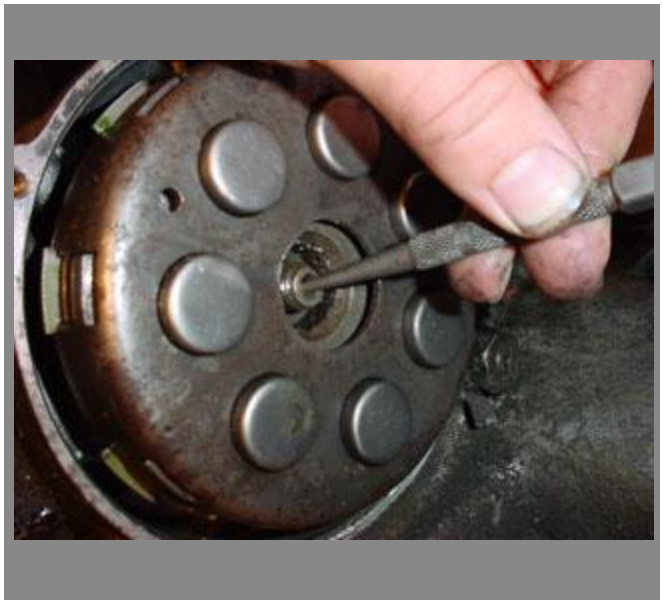
Unscrew the philips head screws and remove the backing plate.

Collect the backing plate. Underneath the plate are a few O-Ring style buffers, remove those as well.

Now whack the holy crap out of the rear axle using a punch as shown. Do NOT just hit the axle itself, you risk damaging the threads for the hub nut.

Once the rear axle comes out, put it aside and undo the cotter pin on the brake actuating cam.

Unhook the spring and pull the brake cam out of the engine case. Collect all the pieces you get.



Now back to the clutch where we left off earlier. With the flywheel side of the case removed, you can get the crankshaft and the clutch out in a few taps of the hammer. Put a metal punch in the hole on the crank arm and use a metal hammer to tap it out. Resist going mad with the hammer you don't want to warp the crank. You'll usually be able to hear the relief of resistance on the bearing race as you hit it. If you're really new at working on motors, a crank puller might be a better bet.

This is the crankshaft. There is a clutch side woodruff key to remove. Two very, very important parts will usually fall out. One is the clutch spacer, the other is the clutch side seal. always replace this seal when going this far into the engine. The clutch spacer goes between the clutch and the clutch side bearing. On injected motors, the spacer will have gearing on it.

Here's the reason we did this project in the first place. This is an excellent example of a pretty catastrophic clutch side seal failure. It appears the clutch side seal had taken a ride on the crank and bashed itself to pieces. We should have known by the water-like oil that came out of the motor. Gas in the oil is a sure sign of a blown clutch side seal.

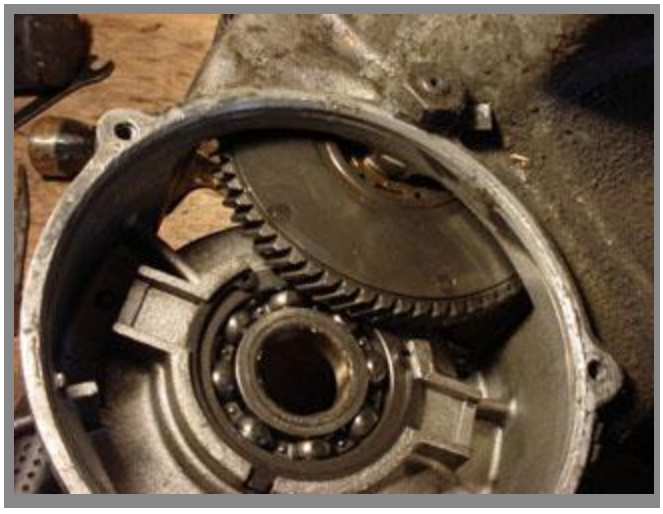
Compress the clutch by squeezing the top plate and the drive gear. We used a wood clamp to do our bidding, but a screw and a few large washers is equally effective. While the clutch is compressed, remove the circlip by hand (you can see the circlip sticking out of the clutch housing just below the drive gear in the picture).

Another view of that pesky circlip.

Release the pressure of the compressor and all the plates will push out of the clutch body. Pull off all of the plates and memorize the order. Always replace the friction and metal plates during a rebuild.

if you have gouges, rust, or loose rivets in your drive gear, it is best to replace the part.

Under the drive gear is a brass bushing and all of the springs and spring caps. Collect them all and store them. If the caps and springs look okay, they may be reused. The brass bushing should always be replaced.



Go back to the motor, now, and loosen the tabbed washer holding on the 17mm nut. Then undo the nut with a socket wrench.

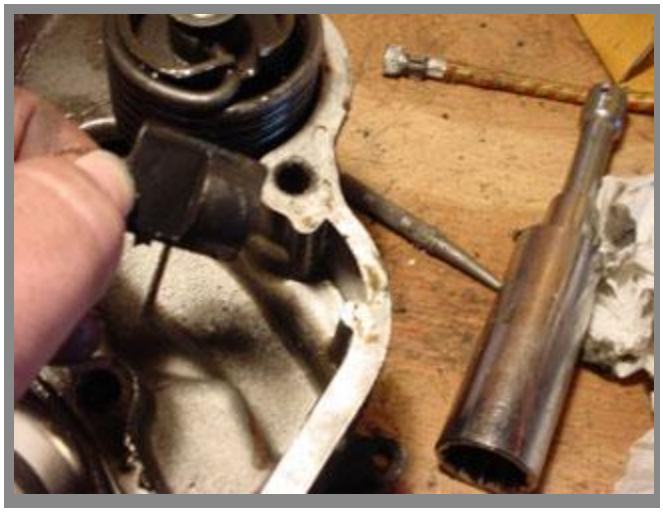
Here are the parts you'll get. A special weird ass washer (square washer), a tabbed washer and a 17mm nut. I've also included a picture of that elusive clutch spacer (bottom center)

Flip the motor over carefully and slowly. Pull the layshaft a little and see if you can get it to budge. If not, use a punch and gently drift it out a little. The reason for caution is there's a bunch of uncaged needle rollers about to fall out.

And here they are! There should be 21 of them (one is hiding in the picture). They are usually reusable, but on a high mileage engine, it might be a good measure just to toss 'em out and get some more.

Now you can just pull the layshaft (primary/spring gear) out at your leisure. This is an example of a very nice layshaft. No visible wear and the rivets are tight.

Pull the plastic oil wiper(s) from the case.



Pull the kickstart buffers from the case.

Push the kickstart spring back with a screwdriver, and pry it up and over the lip. The spring has a bit of tension, but it's not going anywhere. Once the pressure is relieved and the spring is off of the kickstart crown, the lever shaft will pull right out.

Here's the result.

According to this picture the crank is still installed. :) No, we're just eyeing up that big old flywheel side seal. See it? It's black and it's in the middle. We're gonna pry the piss out of it!

A job well done. See those bearings under there? Unless they're definitely fuct, like if the race is broken or half the rollers are missing, it's kind of a bear to get out, so leave it alone. Bearings can go in the industrial parts cleaner, too.

Pick up the clutch cover. Undo this spring, it's under a bit of tension, so watch your fingers.

The spring hold the actuator arm in place as well as the push out actuator. The little brass bearing should have no cuts or pitting in it (other than the oil gap that is cut through the middle), otherwise it's fit for the garbage.

Here is the actuator arm in full. That little tiny O-ring should be replaced every time. It is the cause of super-happy-fun oil leaks. A little O-ring grease will immensely increase its lifespan.

Unscrew the clutch cover breather and spray it with carb cleaner. Make sure there is a path for air to get through as this breather helps to prolong engine seal life. It relieves the pressure of the gear box as the motor heats up. If you can't un-block it, buy a new one.

Welp, that pretty much wraps it up for now. The next step would be to take out the bearings. I tend to like to take it to a shop with the proper tools for that kind of stuff. The last thing you want to damage is a bearing or bearing race. However, The clutch side bearing is held in by two circlips and case pressure. Undo both circlips, noting where they came from. Then you can bash the crap out of it. Same goes for the hub bearing. The trick is getting the needle roller style bearings out without destroying them. You need a special puller for them; however, you could destroy it and buy a new one (since you're probably going to do that anyway). I find the kickstart area engine stud tends to rust like crazy. You should replace that every time as well. If there is case damage like large cracks, you can either take it to a welder (who welds aluminum) or you can invest in matched cases. When the cases are stripped, it might be a great idea to clean them. For about $20 you can put them in a good ultrasonic parts washer at a machine shop,

and for about $7 you can buy a huge can of engine degreaser and go at it with a wire brush and a rag. Really go over every part looking for play, especially the crankshaft. Hold the crank webs in one hand and the con rod in another. See what kind of play you can get. If the play is huge (like a joystick), or it makes grinding noises, you need a new big end bearing, which is an expensive repair. You should also have your crank runout tested at a machine shop to make sure it's not warped, especially if you don't know the history of the motor. Check for gouges and flecks of metal in the cases and find their source. I wish you luck with tearing down your motor. Check other articles on the page for other stuff to do in the meantime :) I'll have a full rebuild suite soon.