Flexible Fuel Vehicles

(M/s. SUGUNA AUTOMOBILES)

PROJECT WORK

Submitted by

A. ARVINDH PRAKASH

C. A. ARUN KUMAR

T. SUNDARRAJ

Under the Guidance of

MR. V. VELMURUGAN M E,
Senior Lecturer

1998-1999

IN PARTIAL FULFILMENT OF THE REQUIREMENTS
FOR THE AWARD OF THE DEGREE OF
BACHELOR OF ENGINEERING
in Mechanical Engineering
OF THE BHARATHIAR UNIVERSITY

Department of Mechanical Engineering

Kumaraguru College of Technology

COIMBATORE - 641 006.

Bonafide

DEPARTMENT OF MECHANICAL ENGINEERING

KUMARAGURU COLLEGE OF TECHNOLOGY
COIMBATORE – 641 006.

Certificate

This is to certify that the Project Report entitled

"FLEXIBLE FUEL VEHICLES"

Is a bonafide record of the project work submitted by

Mr._____Register No._____

In partial fulfillment for the award of the degree of

Bachelor of Engineering
In Mechanical Engineering

Branch of the Bharathiar University, During the academic year 1998 – 99.

Head of the Department

12/3/99 Guide

Submitted for the University Examination Held on _____

Internal Examiner

15/3/99
External Examiner

Certificate

SUGUNA AUTOMOBILES

HERO HONDA
AUTHORISED DEALER

No. 4, Dr. MUNUSWAMY GARDEN ROAD
Avanashi Road, COIMBATORE - 641 018
✆ 303637, 380467 Fax : 0422 - 301375

Ref :

Date: 12.03.99

TO WHOMSOEVER IT MAY CONCERN

This is to certify that the following Students,

01. A. ARVINDH PRAKASH.

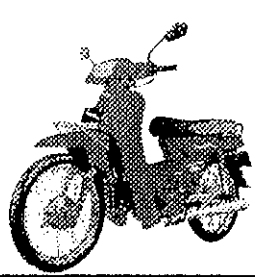
02. C.A. ARUN KUMAR AND

03. T. SUNDARRAJ

of Final Year Mechanical Engineering Branch, Kumaraguru College of Technology, Coimbatore have successfully completed the Project titled **"FLEXIBLE FUEL VEHICLES"** at our concern.

Cordially Yours,
For **SUGUNA AUTOMOBILES,**

Managing Partner.



Synopsis

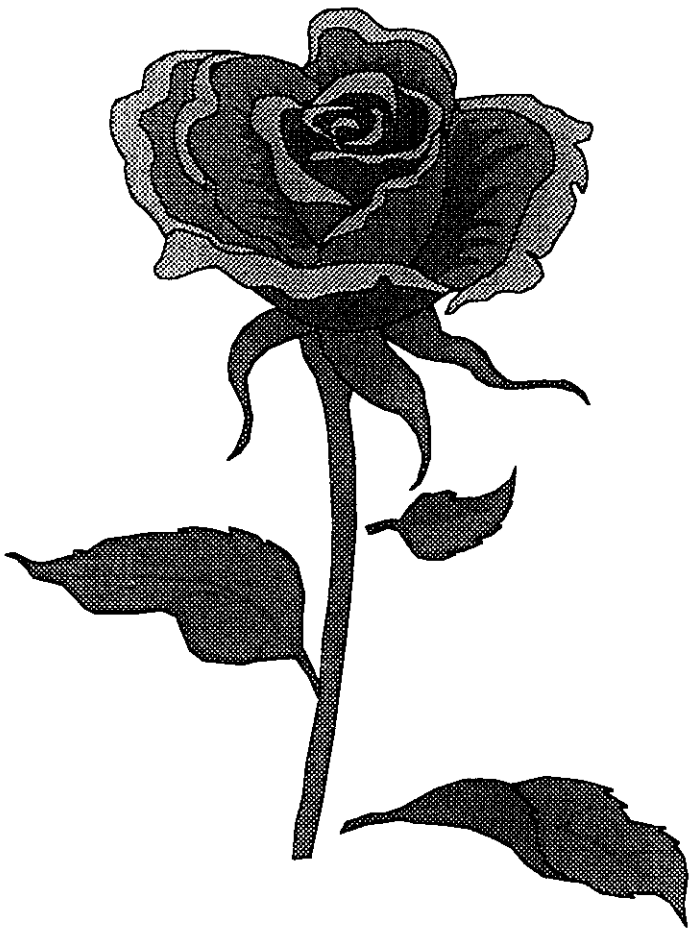
SYNOPSIS

The economy of India (and the World) depends to a large extent on the wheels of transport. The spectre of economic ruin due to depleted oil reserves and resultant hike in the prices of crude petroleum has initiated serious Research efforts pertained towards alternative sources of energy. viable substitutes for motor spirit are gaseous hydrocarbons, hydrogen gas, alcohol's and electricity in addition to biogas.

Vehicles that run on Hydrogen gas and electricity is still in the experimental stage. While ethyl alcohol commonly called as alcohol can serve as a direct/indirect fuel in ICE primarily using gasoline and is used as a fuel chiefly in Brazil. Its feasibility as a motor fuel depends upon the successful cultivation and processing of sugar cane. Gaseous hydrocarbons seem to be the best immediate option presently available. They are mainly CNG and LPG.

This project aims at studying the feasibility of the alternate fuels and modifying an existing vehicle for optimum performance under these alternate fuels.

This project deals with the techno-economic aspects, development and other available options to convert vehicles with minor modification to flexible fuel use (i.e., any fuel like gasoline, unleaded gasoline, premium Gasoline, methanol, ethanol, LPG, CNG, Kerosene, Diesel, Electricity, Bio-Mass etc.,)



Dedicated
To our Beloved
Parents, Teachers & Friends

Contents

Contents

Acknowledgement

Acknowledgement

Anything and everything on earth can be successful only with the advice and support of many well wishers. We take this opportunity to express our gratitude.

We are highly indebted and grateful to our guide **Mr. V. Velmurugan**, Senior Lecturer, Department of Mechanical Engineering for his constant support and guidance rendered by him to us during the course of this project work.

We thank our beloved Professor and Head of the Department **Dr. T. L. Seetharama Rao**, for his invaluable advice that really motivated us to reach our goal.

We express our gratitude to our Principal **Dr. K. K. Padmanaban** and his management for the facilities provided in our college to accomplish this project.

Though words are not enough, but it is all that we have got to express our deepest gratitude to **Mr. Siva Kumar**, Automobile Engineer for being a beacon to us from the conceptualisation to the realisation of this project.

We thank **M/s. Suguna Automobiles**, Coimbatore, for providing us all the materials and facilities to carry out the testing and other related activities pertained to the project at their concern.

We also thank all our **teachers and non – teaching staffs** in the Department of Mechanical Engineering for their Implications and constant Encouragement towards this project.

Last but not the least, we thank our **parents and our friends** for their invaluable timely help, sacrificing what ever they can for the successful completion of this project.

Brief of Sponsorer

Brief of Sponsorer

Profile of M/s. Suguna Automobiles the Sponsorer of the Project:

M/s. Suguna Automobiles was established in the year 1984 as a Service unit at Munnuswamy Gardens, Avinashi Road, Coimbatore.

They are engaged in sales and service of the Hero Range of Automobile Vehicles. The investment of the company is around Rs.5 Crores.

They are now currently the sole dealer, distributor and service Provider for the Hero Honda/Hero Motors range of vehicles. They currently hold the best dealer award for south India in 1997-98.

The company has registered a turn over of Rs. 35 crores during the Year 1998-99.

Nomenclature

Nomenclature

S.No.	Acronym	Expansion
1.	BHP	Brake Horse Power
2.	BOD	Biological Oxygen Demand
3.	CC	Cubic Capacity
4.	CFR	Co – operative Fuel Research
5.	CI	Compression Ignition
6.	Cm	Centimeter
7.	CNG	Compressed Natural Gas
8.	CO	Carbon Monoxide
9.	Dia	Diameter
10.	HC	Hydro carbons
11.	ICE	Internal Combustion Engine
12.	LPG	Liquified Petroleum Gas
13.	M	Metre
14.	MM	Milli Meter
15.	Nox	Oxides of Nitrogen
16.	PVC	Poly Vinyl Chloride
17.	SI	Spark Ignition
18.	TWC	Three Way Converter

Introduction

Introduction

The economic prosperity of a nation has traditionally been linked to Its level of energy consumption. With the advent of the industrial revolution In the west, there was a quantum growth in consumption of fossil fuels like Coal and later petroleum and gas, which were cheap and easily available.

The total share of world energy supplies by coal peaked in 1920's but Now it only caters for 26% of the global energy need. Whereas the share of Oil has risen to nearly 40%

Reducing dependence on improved oil is so far more feasible and Attractive option. This can be achieved by compiling measures for Increasing the efficiency of energy use and by substitution of oil by energy Sources, wherever feasible.

Energy conservation is also a more economic option than increasing Oil supply, as constrains in saving one unit of energy is substantially less Than investments needed in supplying an incremental unit of energy at the End point. Increasing the efficiency of energy use is also the most effective Way to protect the environment, because an un-burnt fossil fuel does not Emit pollutants.

Energy conservation does not mean curtailing the use of energy at the Cost of Industrial and economic growth, not does it mean sacrificing basic? Personal requirements; rather it means more efficient utilisation of energy Resources, ensuring the same level of economic activity with lesser input of Energy. It also implies substitution of expensive imported energy with Cheaper and more plentiful indigenous energy sources.

With the current level of production/consumption, it must be recognised that our countries hydrocarbon reserves will not last indefinitely (I.e., for not more than 20 to 30 years). Hence it is imperative to start Harnessing non-conventional sources of energy. In the long run the Advanced industrial nations will be able to develop technology to master Alternative energy sources. These nations may perhaps be able to live with Zero or even negative growth in energy rates during the transition period by Increasing their efficiency, but the same option may not be available to Developing countries like India, which have to industrialise rapidly to meet The growing needs of the people.

At a stage, when we have invested heavily in the automotive industry, It will be quite uneconomical to introduce drastic changes in automotive Design for the sake of alternate fuel. Hence, fuels that involve simple or no Modifications in the ICE are required.

The Alternative Option

The Alternative option

The various alternatives available for running an automobile are

a) Liquid fuels

#1. Gasoline,

#2. UN-leaded Gasoline,

#3. Premium Gasoline,

#4. Ethanol,

#5. Methanol,

#6. Ethanol,

#7. Kerosene &

#8. Diesel.

b) Gaseous fuels

#1. LPG,

#2. CNG,

#3. Biogas &

#4. Hydrogen.

c) Miscellaneous

#1. Electricity,

#2. Solar &

#3. Turbo Electric Transmission.

The aim of this project is to modify an existing gasoline based SI ICE For running optimally on all fuels virtually available.

Desired Features Of Engine Fuels

Desired features of Engine fuels

1. Anti knock characteristics:

In SI ICE, spontaneous ignition before the spark passes generates ultra High velocity pressure waves giving rise to "knock". The phenomenon is Apparent as a sharp metallic hammering from the engine cylinder. The CFR engine is used to determine the octane. Pure normal heptane is Arbitrarily assigned an octane number of zero, and pure 2,2,4-trimethyl-pentane (iso-octane) is assigned an octane number of 100. The Percentage of standard iso-octane by volume with n-heptane in the Matching blend is designated as the octane number. Fuels with a higher Octane rating is preferred. If the octane number of a fuel is greater than 100, it is referred to as the 'performance number'. To test the fuel. Various blends of n-heptane and iso-octane are used in a CFR Engine and Their knock characteristic is matched with that of the fuel under test.

Conclusion: Fuels with high octane rating are preferred (i.e., fuel that Are good anti-knock agents).

2. Volatility:

The volatility requirements of engine fuels are quite contrary. A high

Volatility is desirable from the point of view of startability and good Distribution, whereas the consideration of storage stability, vapour-Locking and carburetor icing dictate the use of low volatile fuels. In Practice, therefore, a compromise is made and depending upon their use, The high and low volatile fractions are blended in suitable proportions.

Conclusion: Fuels with medium volatility are preferred.

3. **Calorific Value:**

The fuel should have a higher calorific value, because the calorific Value determines the power output

Conclusion: Fuels with higher calorific value are preferred.

4. **Gum content:**

Usually the unsaturated hydrocarbons containing more than one Double bond is chemically unstable. They react either with air or with Each other to form a rubber like substances called gum. This gum can Precipitate in the fuel feed system and in engines to cause difficulties.

Conclusion: Fuels with minimum or no gum content are preferred.

5. **Sulphur Content:**

A high sulphur content is obviously undesirable. Some of the sulphur Compounds restrict the action of tetra-ethyl lead while some of them

Form Corrosive compounds, e.g., sulphurous acid.

Conclusion: Fuels with minimum sulphur content is preferred.

6. Purity:

Water and sediments are usually present in oils and can cause lot of Difficulties. The water and sediments are referred as bottom sediments and Water BSW. These sediments mainly contains dusts and adulterants such as Cheap quality oils.

Conclusion: Fuels with high purity is preferred.

Liquid Fuels

The liquid fuels we will be discussing are

1. Gasoline,
2. Unleaded/premium gasoline,
3. Ethanol,
4. Methanol,
5. Kerosene &
6. Diesel

Regular/Unleaded/ Premium Gasoline

Gasoline

a) Advantages

1. Motor gasoline is an ideal fuel for SI Engines,
2. Light Weight per BHP developed,
3. Low boiling point,
4. High octane rating &
5. Low freezing point

b) Availability

Gasoline exists in nature as an aromatic Hydrocarbons. It is Found as a constituent of crude oil below the surface of the earth. The Crude oils are a mixture of parraffinic, naphthenic, and asphaltic.

The crude oil, which comes from wells, contains impurities of Water, inorganic solids like sand, and gases such methane, ethane etc.,

c) Production

The crude oil is first passed through a centrifugal separator, Which removes most of the water, solid impurities, and wet gases. The crude oil is then sent for distillation. The modern refining

Processes include distillation, cracking, polymerisation, etc.; the main

Aim is to economically obtain the maximum quantity of gasoline along

With desired properties of various products.

Distillation is a process of separation on a molecular basis and

On the basis of the boiling point of various fractions. The

Fractionating column is as in fig 1 and the process in Appendix A.

d) Types:

Gasoline is of three types namely

a) Regular gasoline,

b) UN-leaded gasoline &

c) Premium gasoline.

These types of gasoline's are classified according to the

Variation in their lead content. Lead is generally added to gasoline to

Increase anti-knocking property of gasoline. Lead is added to get a

Higher octane rating for the fuel and it is generally added in the form

Of tetra ethyl lead.

Regular gasoline has the highest lead concentration compared

To premium and UN-leaded. The chart on Table 1 gives the

comparison Between UN-leaded/premium with that of regular gasoline.

Premium and UN-leaded gasolines use a special type of exhaust Chamber called the catalytic converter the diagram is depicted in Figure 2 and the description on appendix B.

e) Modification:

Since the vehicle to be modified is actually designed to run on Gasoline there is no need for modification. The vehicle can as such be Run on gasoline. In case of running on unleaded gasoline/ premium Gasoline fittment of a catalytic converter to the exhaust is necessary. In India only regular and unleaded gasolines are available.

f) Disadvantages:

1. Costly,
2. Scarce &
3. Possible chance of depletion.

Ethanol

Ethanol

a) **Advantages:**

1. Cheap,
2. Abundant,
3. Pollution Free &
4. Can be used directly with SI ICE.

b) Availabilty:

Our country is the largest sugarcane producer in the world after Brazil. Sugarcane is one of the chief feed stock for the manufacture of Ethanol. Approximately 90 litres of ethanol is obtained per tonne of Sugarcane.

An interesting feature of ethanol is that it can even be produced from Waste products some of the wastes, which can be used for manufacture of

Ethanol is

a) Agricultural Product waste,

b) Vegetable and Fruit waste &

c) Wood waste.

Agricultural product waste:

These waste include food processing waste such as cheese whey and Cannery waste, vegetable and fruit waste etc.,

Cannery waste can be processed to provide single cell protein Methane or ethanol. Ethanol production from cannery waste remains Commercially unproven.

Cheese whey is easily fermentable and contains 6.5% solids including 4.5-5% sugar in the form of lactose, 0.8% protein and mineral salts. Efficient ethanol production from cheese whey would require each dairy Processing plant to have its own production plant on site. Initial Calculations indicate that transportation of whey more than 100 miles Would make costs prohibitive.

One problem with cheese whey is the high BOD of the residue of the Ethanol production process. If a sewage treatment type of facility is not Used it becomes a major pollutant.

Vegetable and Fruit wastes:

Fruit crops are unlikely to be used as a feed stock for alcohol fuels Because of their high market value for direct human consumption.

Wastes from fruit processing and distressed fruit are potential feed Stocks, which can be harnessed.

Various vegetables like sugar beets, sweet sorghum and fodder beets may be used for the production of ethanol.

Wood waste:

A strong acid or dilute acid may be used for the hydrolysis of wood Wastes. Approximately 80% of the sugars are fermented.

c) **Production:**

Ethanol or Ethyl alcohol is a hydroxyl derivative of ethane. Ethanol is Primarily produced by fermentation of carbohydrates such as saccharin (sugarcanes, sugar beets, molasses, and fruit juices), starch (cereals & potatoes) and cellulose (wood waste and sulphite liquor) Fermentation yields ethanol and carbon-di-oxide. This process is completed in about three days. The raw material can be grown specially to produce ethanol. The concentration of alcohol is of the order of 10 to 20% which is increased by distillation.

d) Modification:

As such any SI ICE does not need any kind of modification of its parts

but a change over from a plastic float of the carburetor to a metallic float since ethanol is corrosive. Alteration of the air gap to 1.1 turns of the screw is needed. Ethanol can either be used alone or blended with gasoline.

e) Disadvantages:

1. It has a potential conflict with food crops,
2. Disposal of sullage is a problem &
3. By nature ethanol is corrosive towards plastic and PVC.

Methanol

Methanol

a) Advantages:

1. Cheap,
2. Abundant,
3. Pollution free &
4. Widely available.

b) Availability:

Potential feed stocks for methanol production are natural gas, coal and biomass. Table 2 gives the quantity of methanol derived from the raw Materials.

Our country is reported to have good reserves of natural gas which can be converted to methane. Natural gas that is burnt off as waste in the petroleum refinery could also be used for methanol production.

An attractive aspect in the production of methanol is that it can be Produced from agricultural and municipal wastes.

Two primary ways exists for producing methanol from biomass.

The first is anaerobic digestion of wet biomass (e.g., sewage) to

Produce methane, which in turn can be used to produce methanol.

The second method is the partial combustion of dry bio mass(agricultural and municipal wastes) to produce syngas (carbon Monoxide and water), which in turn can be used to produce methanol.

A primary advantage of using waste material as a feed stock is that it Saves money and result in less environmental degradation than using Other feed stocks.

Our country can boost up its methanol production if we use these feed stock efficiently.

c) Production:

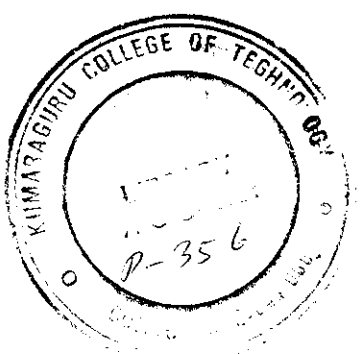
Methyl alcohol commonly called methanol is a hydroxyl derivative of methane. It can be produced by its liquification, by pyrolysis, or by its reaction with high-pressure hydrogen. This will result in liquid fuel in a Similar way as described for the production of liquid fuel from municipal Waste. Methanol can also be produced by the gasification of coal to give carbon monoxide and hydrogen, which can later be converted to a liquid hydrocarbon by the catalytic process.

d) Modification:

A SI ICE can be made to run on methyl alcohol without any Modification at all.

e) Disadvantages:

1. indiscriminate gasification of biomass could lead to soil erosion and Desertification &
2. Methyl alcohol is highly poisonous.



Kerosene

Kerosene

a) Advantages:

1. Cheap,
2. Easily available &
3. Can be easily stored.

b) Availability:

Kerosene is found in crude oil, found below the earth's crust. Crude oil contains gases dissolved under pressure, solids as suspended particles and also in a dissolved state.

c) Production:

Kerosene can be separated from crude oil by means of fractional distillation (appendix A).

d) Modification:

As such SI ICE does not need any kind of modification for kerosene to be used. Kerosene can be either blended or used directly. The spark plug gap must be reduced.

e) Disadvantages:

1. Heavy carbon deposits inside the cylinder,

2. Heavy smoke,
3. Startability problems &
4. Noise level is high.

Diesel

Diesel

a) Advantage:

1. Cheap,
2. Widely available &
3. Storage and handling is easy.

b) Availability:

It is available as a hydrocarbon and is found in nature as crude oil and is present beneath the earth crust. Diesel fuels are used in CI ICE.

c) Production:

The crude oil which is obtained from oil wells are sent through the fractionating column and the diesel is separated (appendix A).

d) Modification:

The ignition temperature of diesel is very high so for usage in SI ICE the diesel before passed onto the engine must be preheated. This is done by passing the diesel through the exhaust pipe, by means of a copper tube. This utilises the principle of counterflow heat exchanger. The diesel is kept in the main tank, from the main tank the copper tube takes the diesel into the silencer and then out of it to the Y union. To other side

of the Y union, the auxiliary tank containing petrol is connected. The outlet of the Y union is connected to the carburetor inlet.

The Y union is a two input and one output junction and control (it allows only one input at a time)

During starting petrol is allowed in through the Y union and idled for 2 minutes, then the Y union is turned towards diesel. While the diesel passes in through the preheater the temperature increases making the diesel to evaporate. During stopping of the engine the Y union is turned towards petrol and idled for 2 minutes and then stopped.

e) Disadvantages:

1. More smoke,
2. High sound compared to gasoline &
3. Starting problems during cold.

Gaseous fuels

The various gaseous fuels we will be discussing are

1. LPG,
2. CNG,
3. Hydrogen &
4. Bio gas.

LPG

LPG

a) Advantages:

1. cleanliness and unadulterated,
2. smoke is completely absent,
3. complete combustion without pollution is possible due to uniform mix of air and fuel,
4. better mixing with air and improved distillation,
5. no need of fuel pump
6. no crank case dilution because of vapour form,
7. high octane rating &
8. better calorific value.

b) Availability:

LPG is linked with petroleum production. It can also be produced by the liquification of butane and propane from natural gas and is stored as pressurised liquid. It is normally fully vapourised before being mixed with air in the induction or suction manifold and therefore forms a homogeneous charge. Hydrocarbons and carbon monoxide emissions are reduced with the usage of LPG, but nitrous oxide emissions are at par with those of petrol engines

c) Production:

Large quantities of propane and butane are liberated during refining of petroleum from the top of the fractionating column (appendix A) and from other refining process. these gases can be compressed and liquified At atmospheric temperatures for comparison chart refer table 3.

LPG has superior anti detonation power compared to premium petrol.

d) Modification:

Minor modification is needed to convert a SI ICE to run on LPG. The gas is taken from the cylinder through a leak proof copper tube insulated with rubber. This connected to the bleeder valve which actually under normal circumstances or petrol operation controls pressure. During operation the petrol supply is kept at off condition on the union while the gas cock is opened the vehicle is started and run.

e) Disadvantages:

1. Storage and handling is difficult,
2. Possible chance of explosion,
3. Needs special leak proof arrangement,
4. Heavy pressure cylinders increase vehicle weight unnecessarily &
5. Positioning the cylinder is difficult.

CNG

Compressed Natural Gas

a) Advantages:

1. cleanliness and unadulterated,
2. smoke is completely absent,
3. complete combustion without pollution is possible due to uniform mix of air and fuel,
4. better mixing with air and improved distillation,
5. no need of fuel pump
6. no crank case dilution because of vapour form,
7. high octane rating &
8. high calorific value.

b) Availability:

CNG or Compressed Natural Gas is related to petroleum production it is found on top of the oil layer beneath the earth crust. It is most abundant than oil and is widely distributed besides environmental and economic advantages.(table 4)

India as such is rich in natural gas reserves and more over in refineries these natural gases are not used and are dissipated or burnt off.

Natural gas has 43% less carbon per unit of energy than coal and it also has a very low sulphur content, as a result it is far less damaging to the environment as compared to other hydrocarbons.(table 5)

The combustion properties make it an excellent fuel for SI engines. As a gas, it mixes readily with air even at low temperatures, thus eliminating the need for mixture enrichment while cold starting or idling.

Natural gas has excellent antiknock properties with an equivalent (R+M/2) octane number in excess of 120 compared to 87 for unleaded regular gasoline and 92-93 for premium. This allows engines designed specifically for natural gas to use higher compression ratios than gasoline engines, with consequent improvement in efficiency.

c) Production:

Natural gas bursts out in pressure when drilling for oil. This natural gas is collected sedimented and compressed to get CNG.

d) Modifications:

The modifications made for using CNG in place of gasolines for SI ICE similar to the LPG conversion kit. The engines using CNG can be classified as lean burn or stoichiometric.

The stoichiometric engines operate with an air-fuel ratio close to the stoichiometric or chemically ideal mixture, in which there is just enough air present to burn all the fuel. There is relatively higher nitrous oxide emissions.

The lean burn engines use an air-fuel mixture which has excess quantity of air. The excess quantity of air dilutes the mixture and reduces the flame temperature and the engine life is enhanced.

In case of converting an SI ICE increasing in compression ratios is needed for the same power output compared to the gasoline counterpart. Which add to the cost and will not be viable.

e) Disadvantages:

1. Low density, so storing is difficult due to the bulkiness of containers &
2. Slower flame speed so there is a power loss.

Hydrogen

Hydrogen

a) **Advantages:**

1. Abundant,
2. Eco friendly,
3. Cleaner &
4. Renewable.

b) **Availability:**

Hydrogen gas is available in the earths atmosphere. It is abundantly available and can serve as the most eco friendly and promising fuel.

Hydrogen as an alternative to gasoline has the great advantage of Almost eliminating the undesirable pollutants. Liquid hydrogen is used with liquid oxygen as a propellant for rockets and space vehicles.

c) **Production:**

Hydrogen can be produced either by electrolysis of water or by the thermo-chemical splitting of water. Electrolysis of water needs electrical energy. The common installations give about 1000 to to 5000 cubic metres of gas per day. They operate at 60-70% efficiency. Some high pressure electrolysers have achieved an efficiency of upto 80%

Hydrogen if used in ICE's increases the efficiency by about 50% as compared to gasolines. The carburation is simple.

d) Disadvantages:

1. Handling is a problem,
2. Because of its low density storing needs super insulated cryogenic cylinders &
3. Procurement is Costly.

Bio-gas

Bio-gas

a) Advantages:

1. Cheap,
2. Pollution free &
3. Easily available.

b) Availability:

Bio gas is widely available almost every where in the world. Small domestic bio gas plants for farmers with two or three cattle are becoming popular in India. Big sewage disposal plants are also working in India.

c) Production:

Bio gas is produced by the fermentation of animal and human waste. The fermentation takes place in an air free closed space. The gas produced consists mostly of methane, carbon monoxide and hydrogen.

The typical composition of bio gas is

Methane	- 60%
Carbon di oxide	- 30%
Hydrogen	- 10%

The calorific value of the gas can be improved by absorbing carbon di

degree celsius. Its use

Technical Specifications

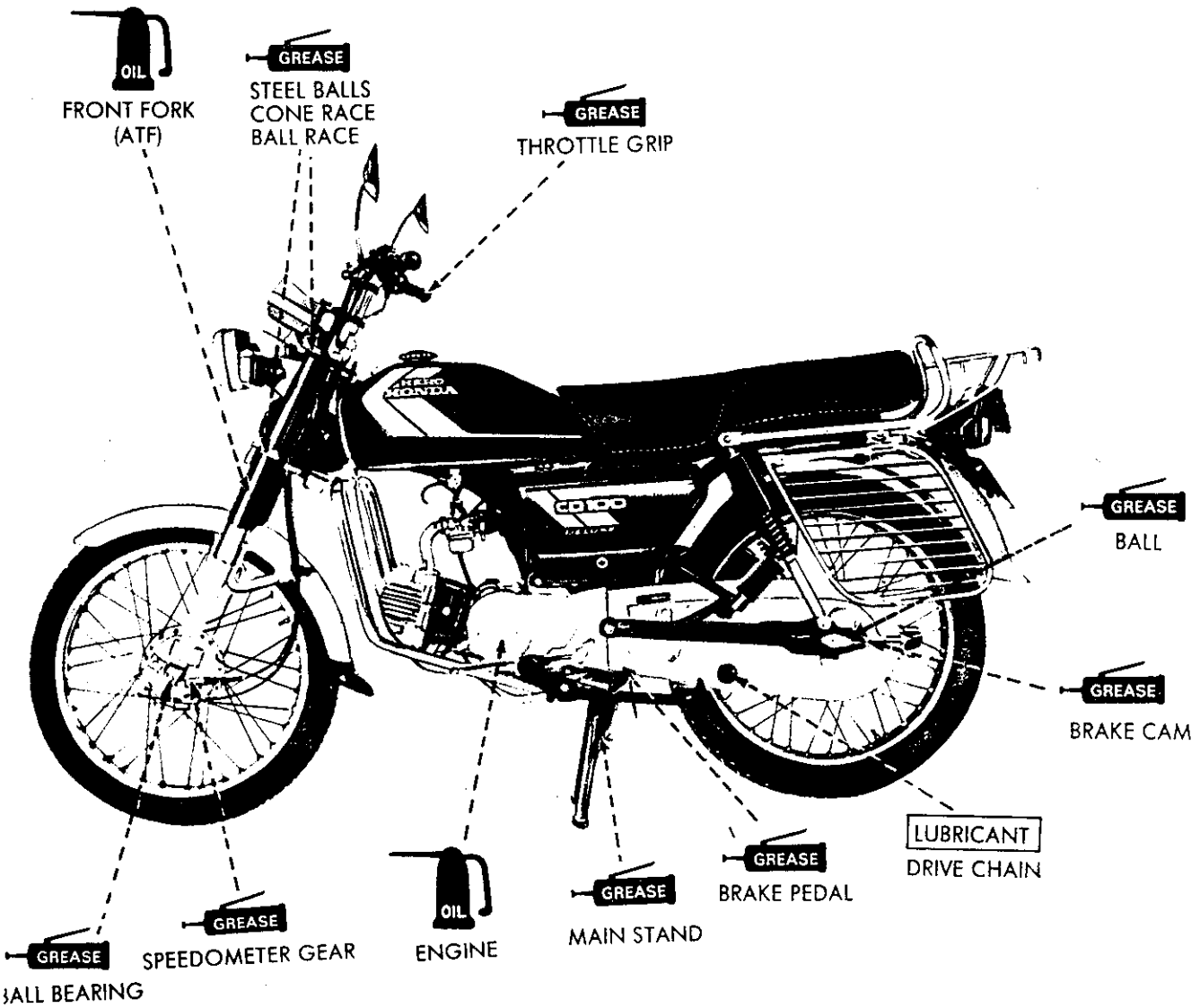
Technical Specifications

Engine Type	4 – Stroke Single Cylinder Air Cooled.
Displacement	97.2 CC
Max. Power	7.20 Bhp @ 8000 RPM
Max. Speed	85 Kms/hr
Transmission	4 – Speed Constant Mesh
Final Drive	Roller Chain
Ignition	Electronic
Starting	Kick Starting
Frame	T – Bone Type
Suspension	Front – Telescopic Hydraulic Fork
	Rear - Double Tube Hydraulic Dampers

Operating Manual

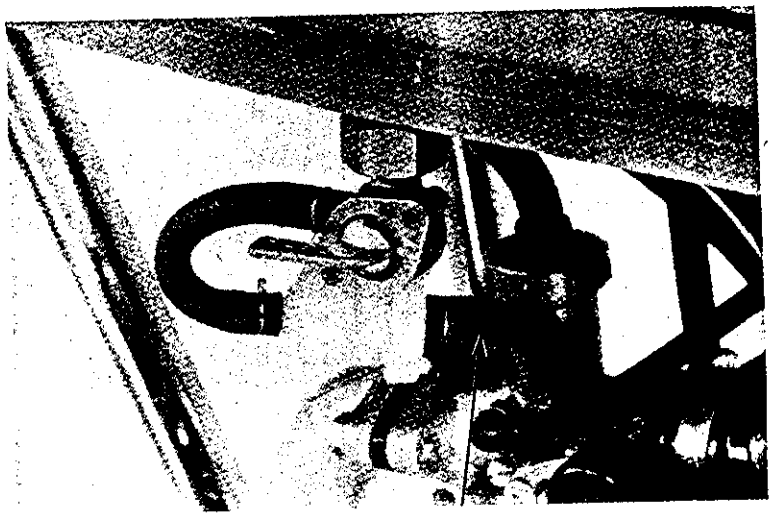
.UBRICATION POINTS

Use any general purpose grease or oil whenever not specified here.
Apply oil or grease to all other sliding surfaces and cables not shown here.



Optional parts: Leg guard, Rear foot step, Saree guard

Check all fuel lines. Replace any part which shows damage or leakage.
Blow air through fuel filter to clean it.

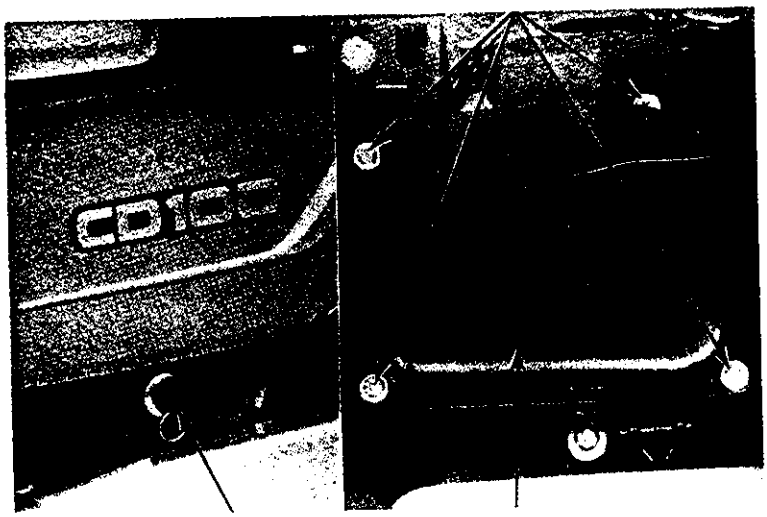


FUEL LINE

\IR CLEANER

Remove left side cover.
Remove air cleaner cover by removing screws.
Remove the element by removing the holder.

AIR CLEANER COVER



INGNITION KEY

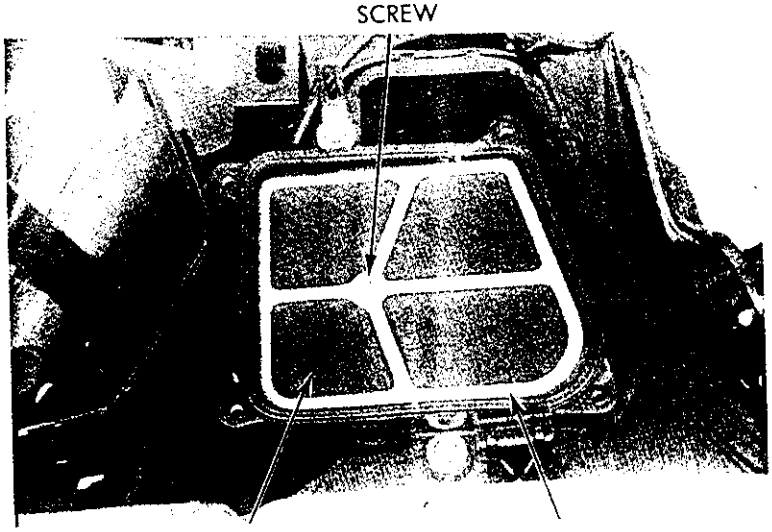
SCREWS

- Wash element in kerosene and allow it to dry.
- Soak the element in oil and squeeze out excess oil.
- Install the air cleaner.
- Install the side cover.

NOTE

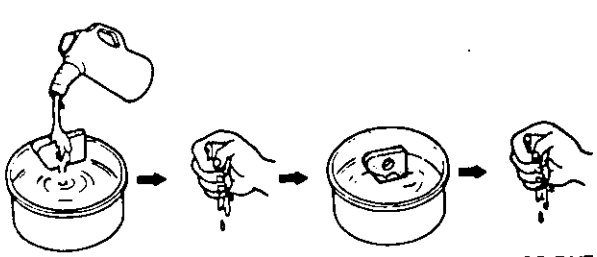
Do not use petrol to wash the element as it may cause back fire and also it may damage the element.

SCREW



AIR CLEANER ELEMENT

HOLDER



WASH

SQUEEZE OUT AND DRY

OIL

SQUEEZE OUT EXCESS OIL

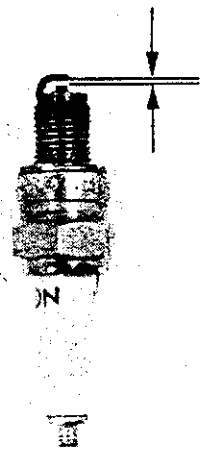
PARK PLUG

Disconnect the spark plug cap.
Remove spark plug with plug spanner.
Check condition of spark plug.
Replace spark plug if there is excess wear of if insu-
ator is damaged.
nspect gap with feeler gauge. Adjust if necessary.

SPARK PLUG GAP
NGK .6 - .7 mm
MICO .6 mm

)TE

Replacement of spark plug-every 15,000 kms.



INDEX MARK

\PPET ADJUSTMENT

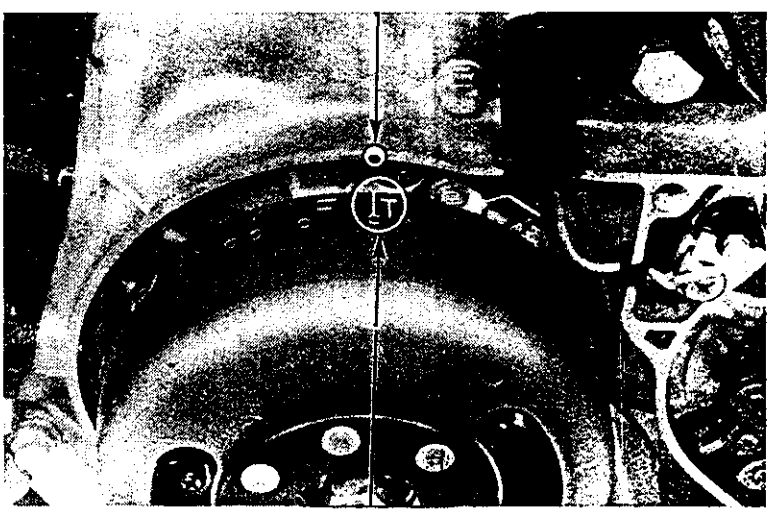
)TE

Inspect and adjust the tappets only when engine is cold.

emove the L. Crank Case Cover.
emove the tappet inspection caps.
otate magnet and allign 'T' mark with notch in rank case as shown in figure.
ispect the inlet and exhaust valve clearances by iserting a feeler gauge.

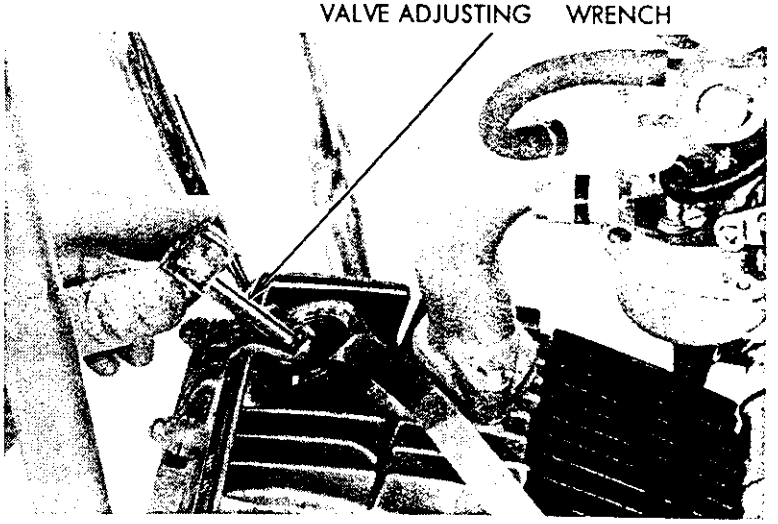
ALVE CLEARANCE: Inlet: 0.05 mm
Exhaust: 0.05 mm

djust by loosning the lock nut and turning the djusting screw till there is a slight drag on the feeler auge.
old adjusting screw and tighten lock nut.
istall tappet caps and Left Crank Case Cover.



'T' MARK

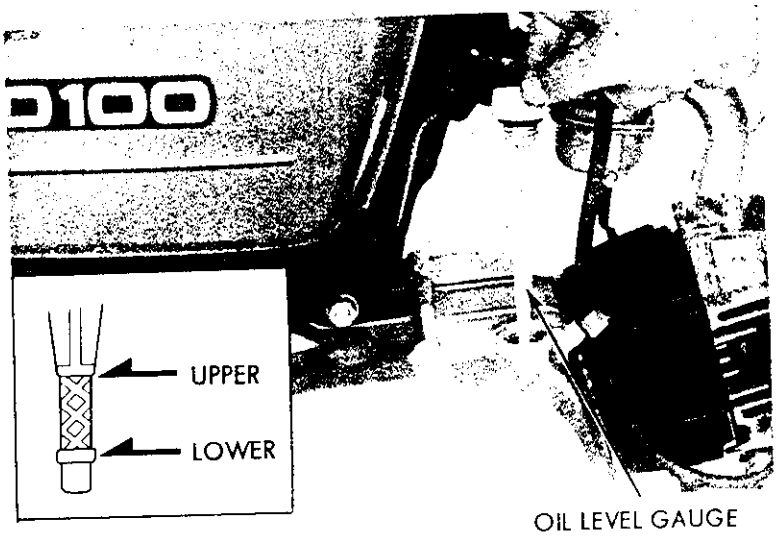
VALVE ADJUSTING WRENCH



INDEX MARK

NGINE OIL CHANGE

Place motorcycle on main stand.
Warm up the engine.
Remove the oil dip stick.
Remove drain plug and let the oil drain out.
Replace drain plug.
Add approx. .65 ltrs. of oil through the oil filler cap.
Check oil level.



OIL LEVEL GAUGE

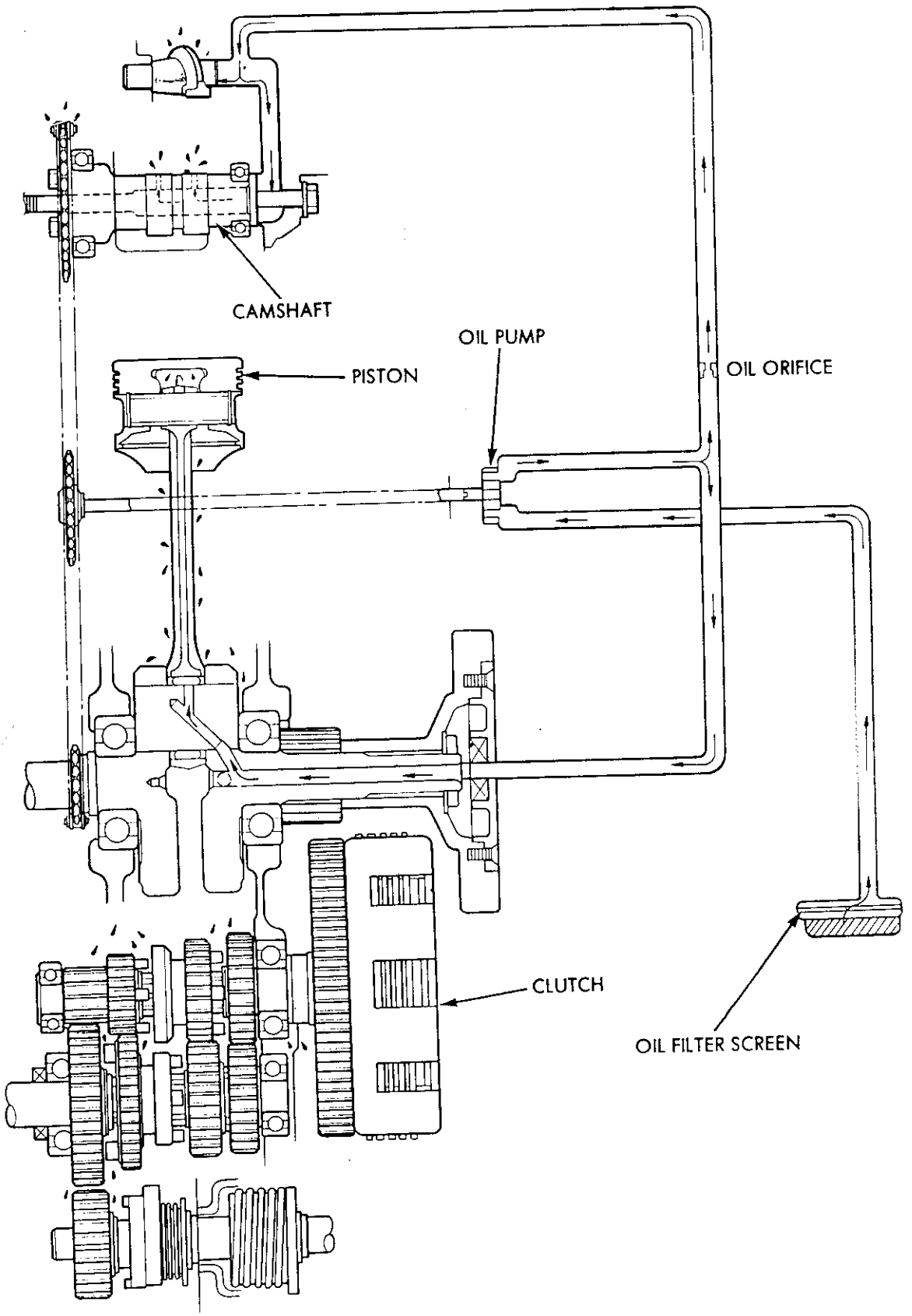
DTE

Make sure that sealing washer is intact.


DRAIN PLUG

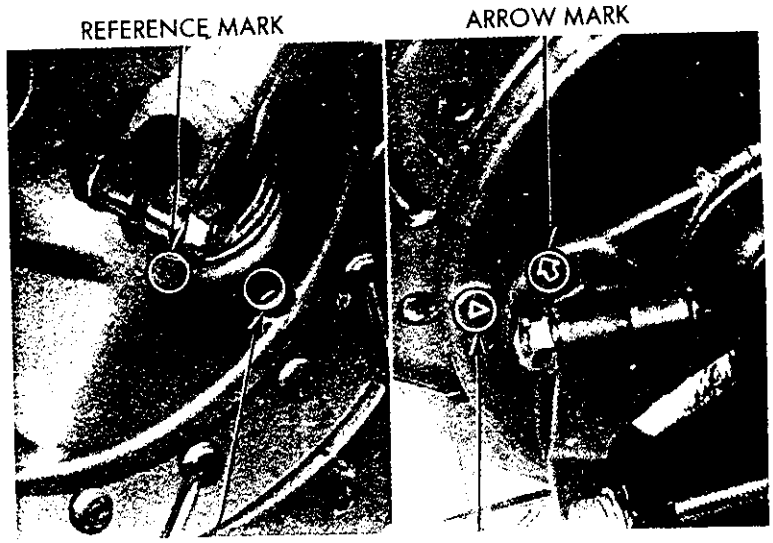
USE ONLY GENUINE MULTI GRADE OIL.

RECOMMENDED BRANDS:
SUPER SERVO 20W40
BHARAT ACTUMA 20W40


CAMSHAFT
OIL PUMP
PISTON
OIL ORIFICE
CLUTCH
OIL FILTER SCREEN

BRAKES

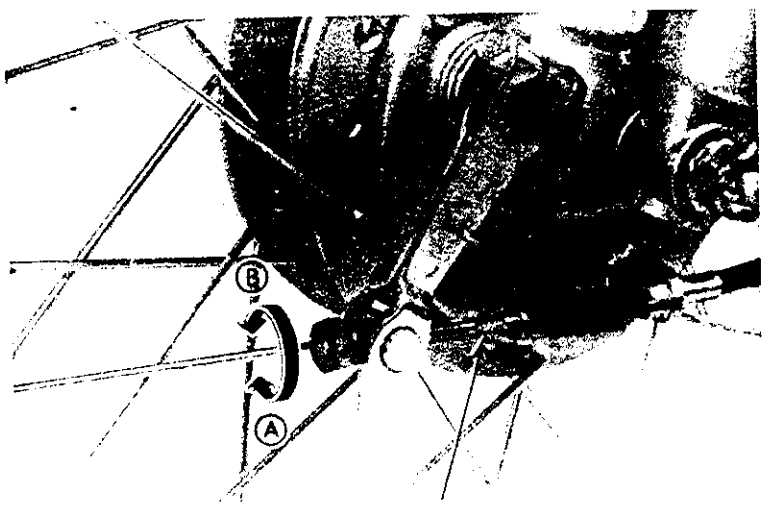
- Replace brake shoes if arrow on indicator plate alligns with the 'A' on the brake panel when brake is applied.



FRONT BRAKE

- Measure the front brake lever free play in lever.
- Loosen the lock nut and turn the adjuster to obtain specified free play.

FREE PLAY: 10-20 mm

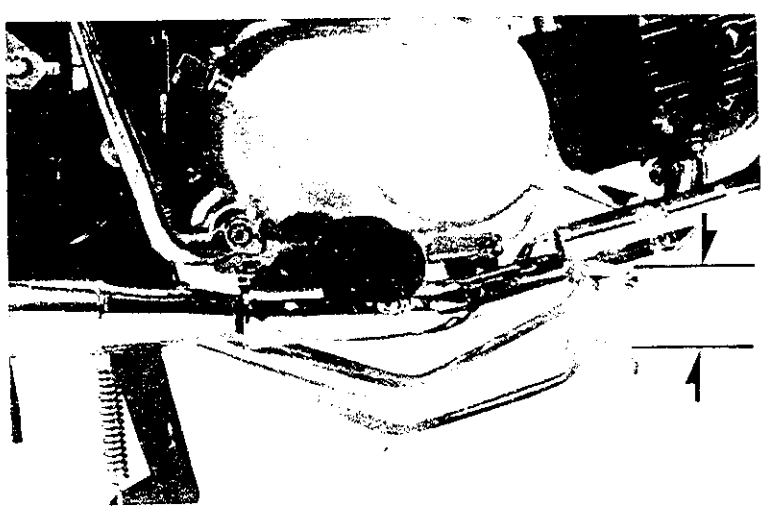


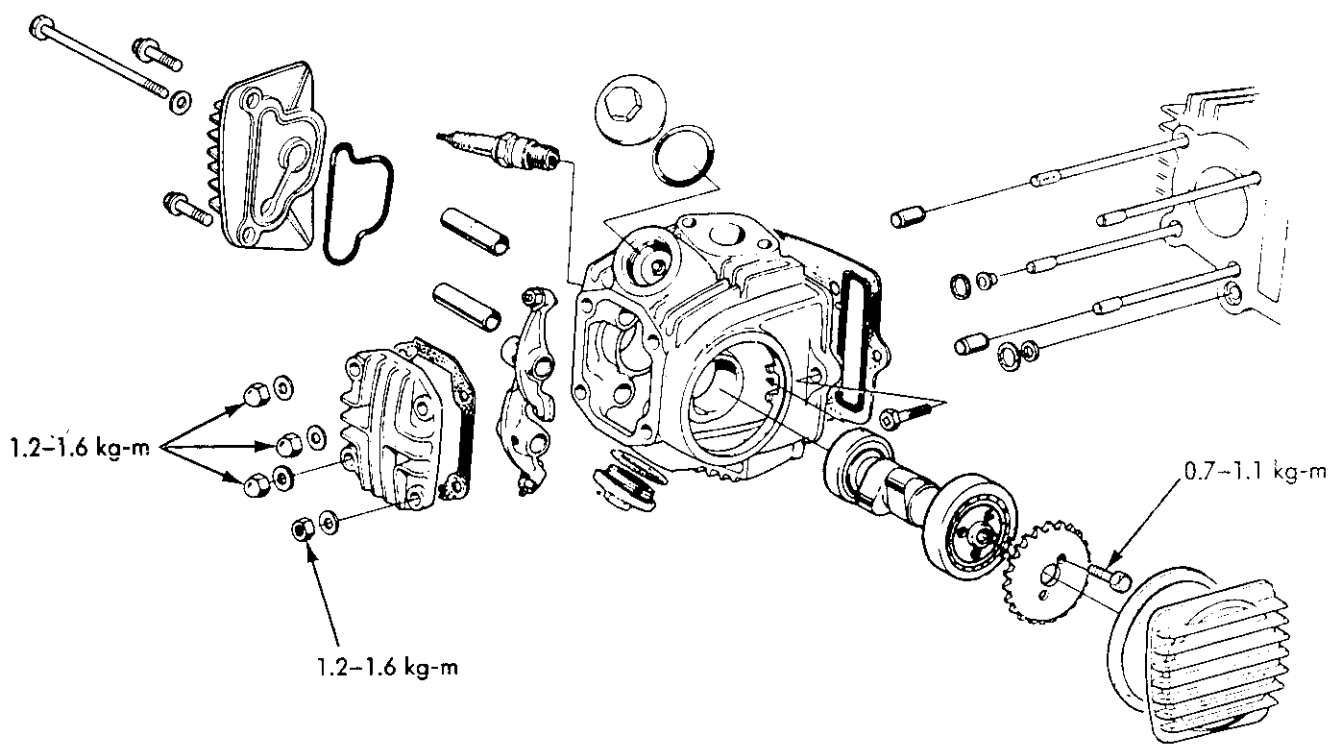
ADJUSTER
(A) Decrease free play (B) Increase free play

REAR BRAKE

- Measure the brake pedal free play before the brake starts to engage.
- Adjust the free play by turning the adjuster nut.

FREE PLAY: 20-30 mm

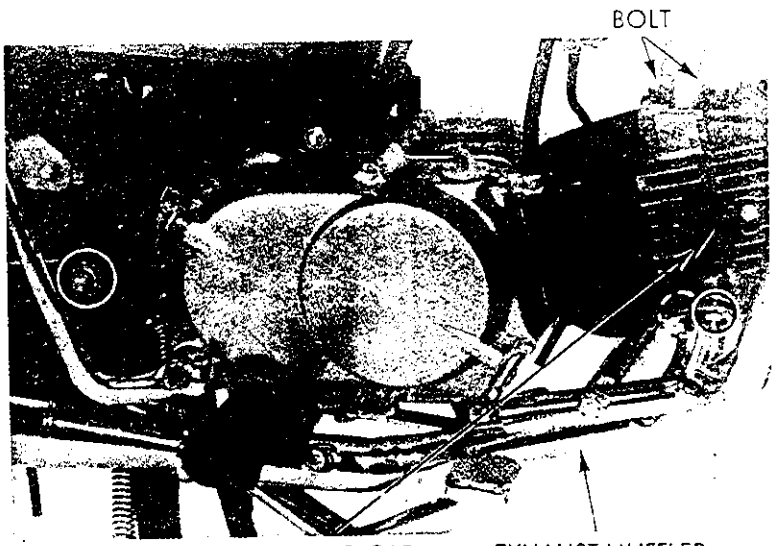



1.2–1.6 kg-m
1.2–1.6 kg-m
0.7–1.1 kg-m

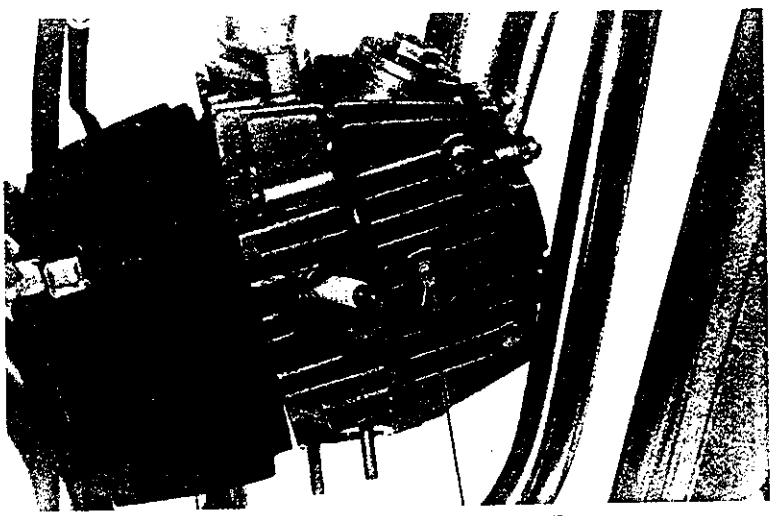
YLINDER HEAD

MOVAL

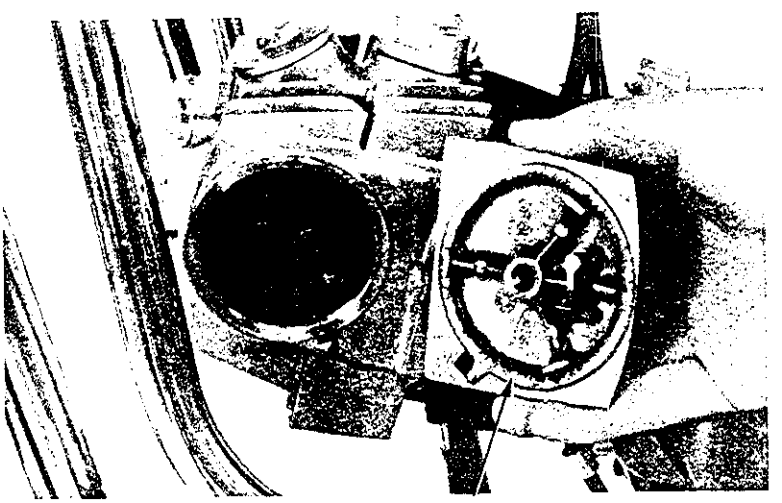
Remove the exhaust muffler.
Remove the inlet pipe bolts.



Remove the cylinder head L. Side Cover by loosning the bolt from right hand side.

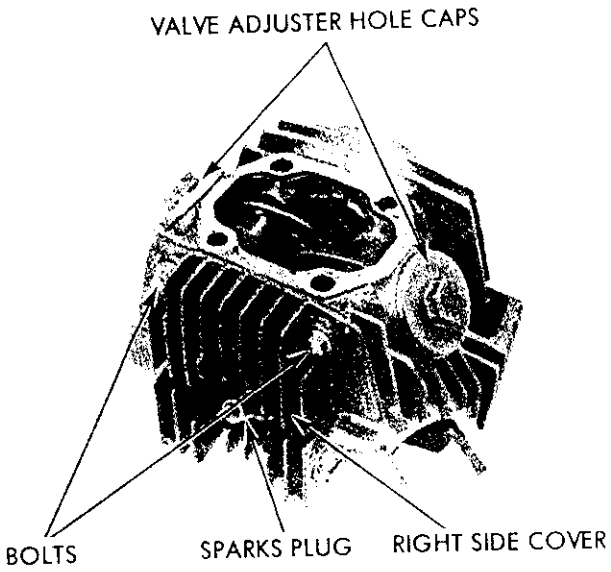


Remove the cam sprocket bolts.
Remove the fastener bolt attaching the cylinder head to cylinder block.
Remove the four cylinder head cap nuts.
Lift the cylinder head out.

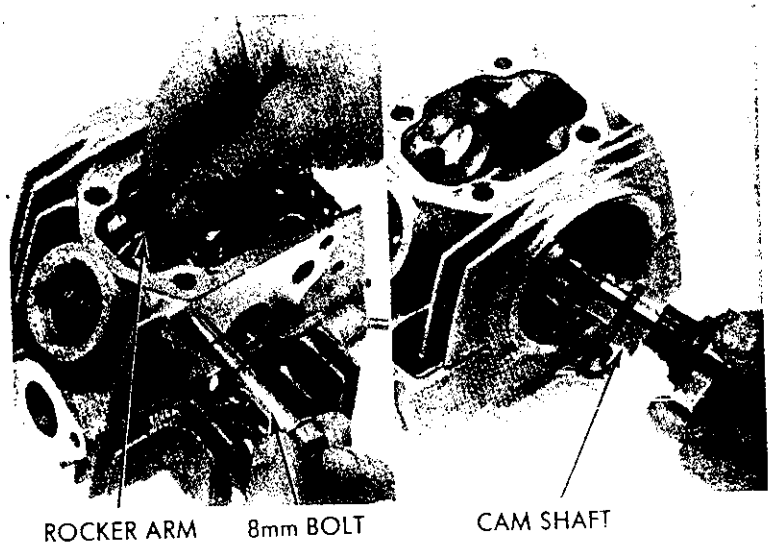


)ISASSEMBLY OF CYLINDER HEAD

Remove the cylinder head right side cover by loosning the bolts.
Remove the spark plug.
Remove the tappet inspection caps.



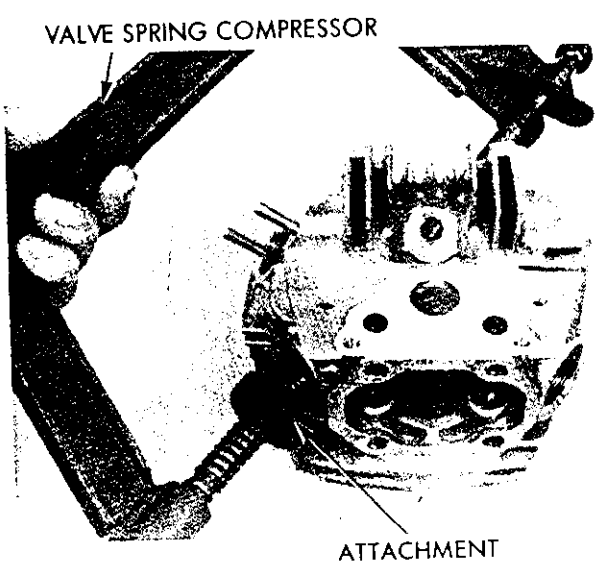
Remove the rocker arm shaft with the help of a bolt.
Remove rocker arm and cam shaft.



- Compress the valve springs with valve spring compressor.
- Remove the valve cotters and valves.

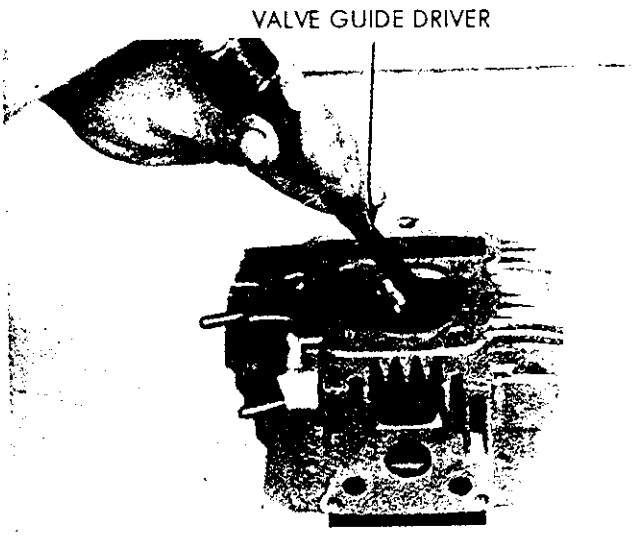
NOTE

To prevent loss of tension, do not compress valve springs more than necessary.

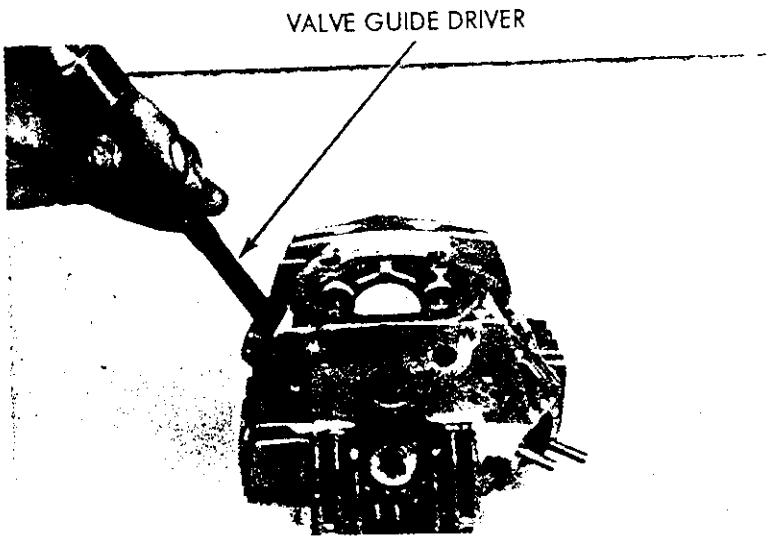


CYLINDER HEAD OVERHAULING

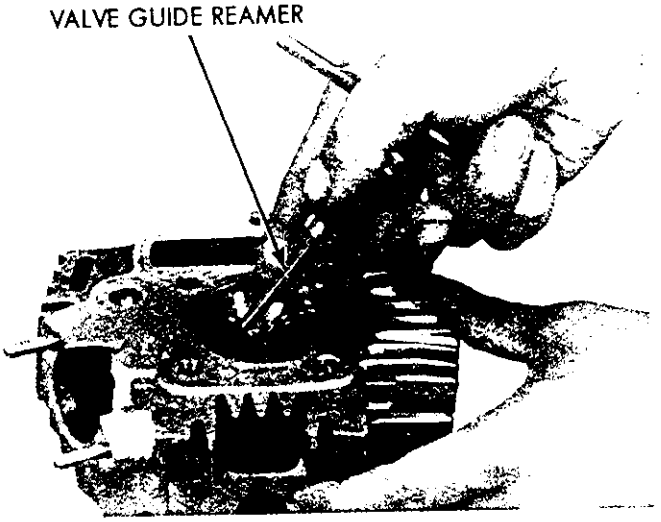
* Remove carbon deposits from the combustion chamber.
* Check all parts for wear/damage.
  Replacement of valve guides
* Support the cylinder head and drive out the valve guides with the driver.



* Install the O'ring on the new valve guide.
* Coat the guide with engine oil.
* Drive in the new valve guide.



* Inspect the inner surface of valve guide.
* Ream the valve guide after instalment.

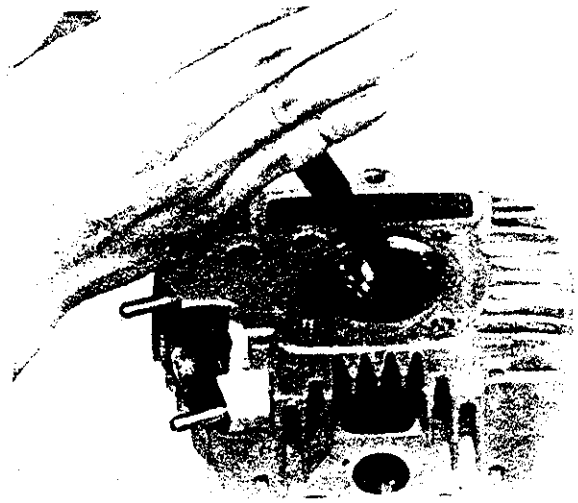


ıLVE SEAT REFACING

ɜan inlet and exhaust valves to remove carbon posits.
ıply a light coating of valve grinding paste to ch valve. Lap each valve and seat using lapping ːk.

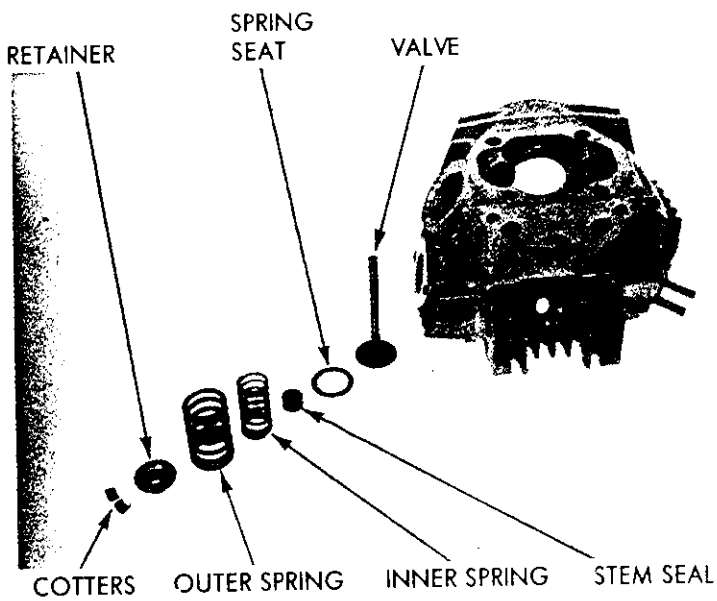
ˈE

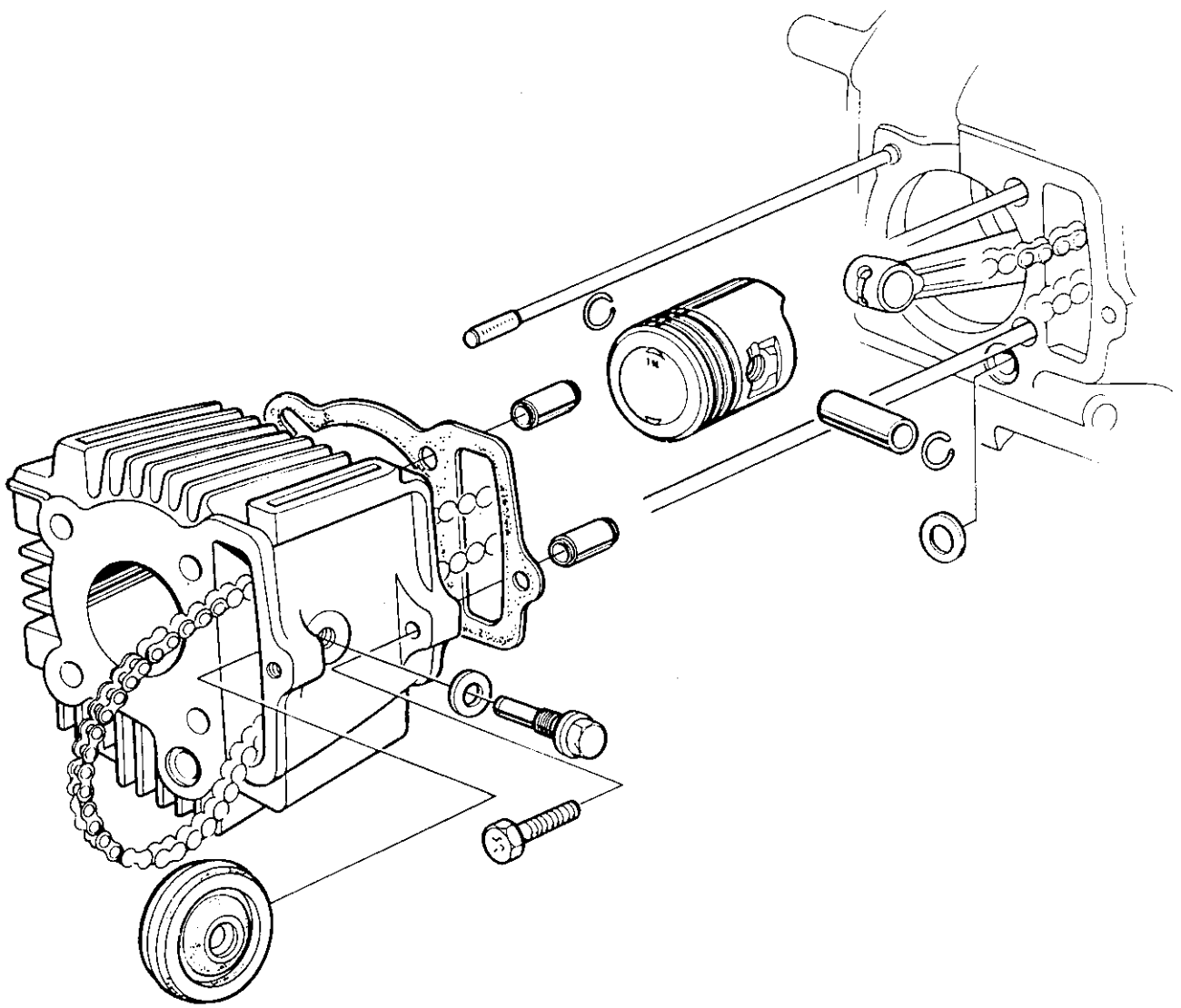
- For best results, first grind with coarse paste and then with fine paste.
- Do not hit the valve but give gentle strokes.



LINDER HEAD ASSEMBLY/ ɔTALLATION

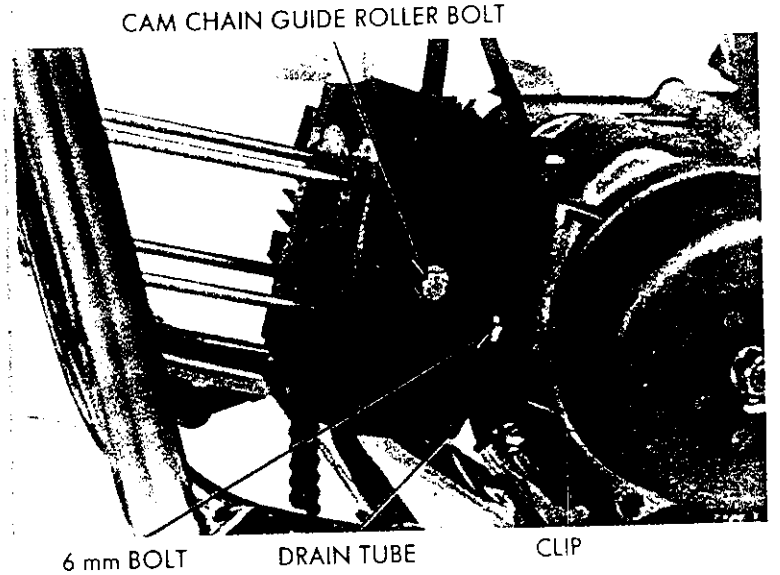
sembly and installation is in reverse order of ːassembly.



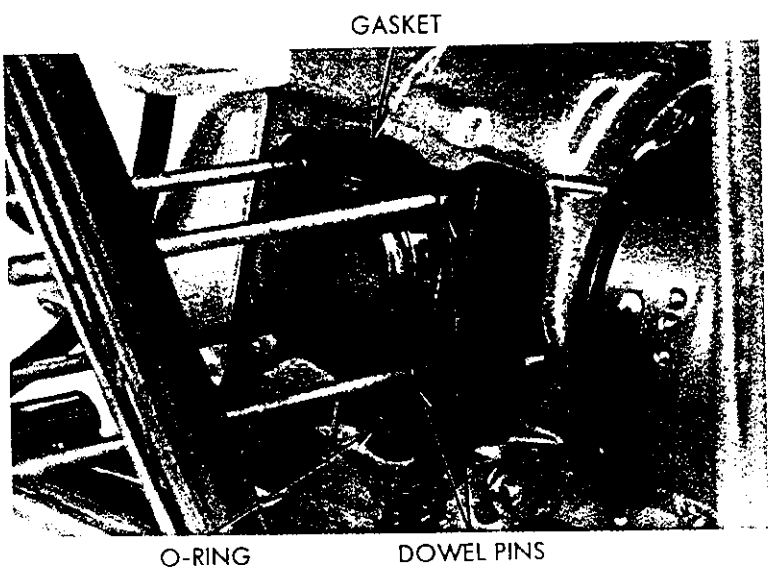


CYLINDER/PISTON

* Remove cylinder head (Refer page No. 14)
* Remove guide rollor bolt and guide rollor.
* Loosen the fastner bolt attaching the cylinder to left crank case.

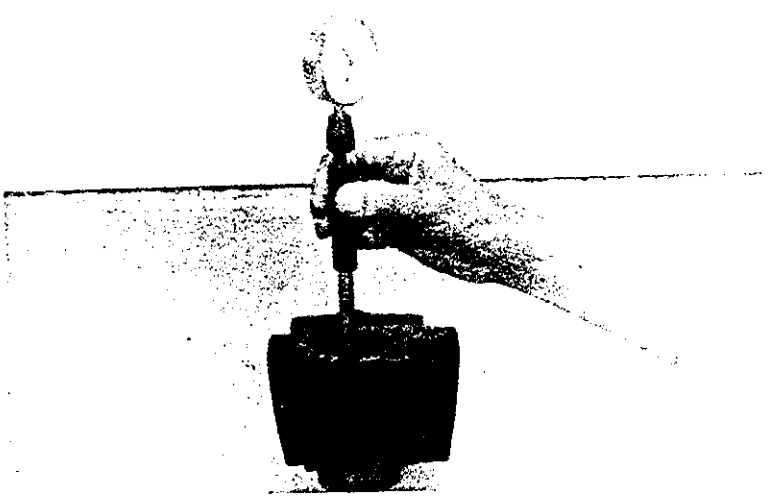


* Remove the O'Ring, gasket and dowel pins.
* Clean off any gasket material from the cylinder and check for wear.



* Measure the inner diameter of cylinder.
* SERVICE LIMIT: 50.06 mm (for standard cylinder)

Add 0.25 mm for consecutive oversize.

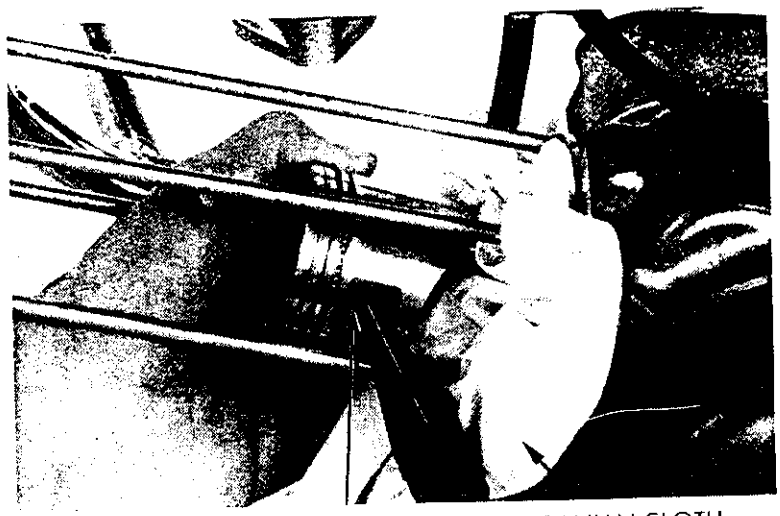


ISTON REMOVAL

Remove circlip with pliers.
Press out piston pin.
Remove the piston.

OTE

Stuff some soft cloth in the crank case to prevent any object from falling into it.

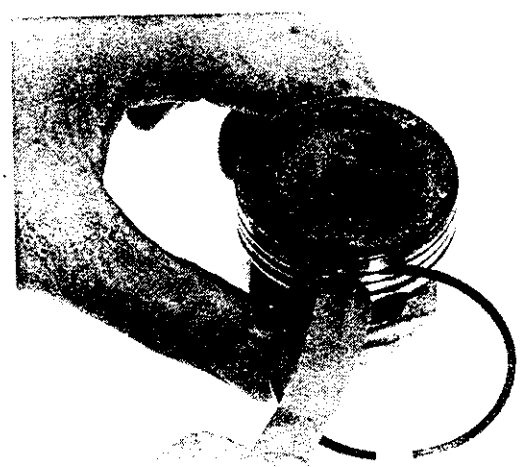


PISTON PIN CLIP BANIAN CLOTH

ISTON/PISTON RING NSPECTION

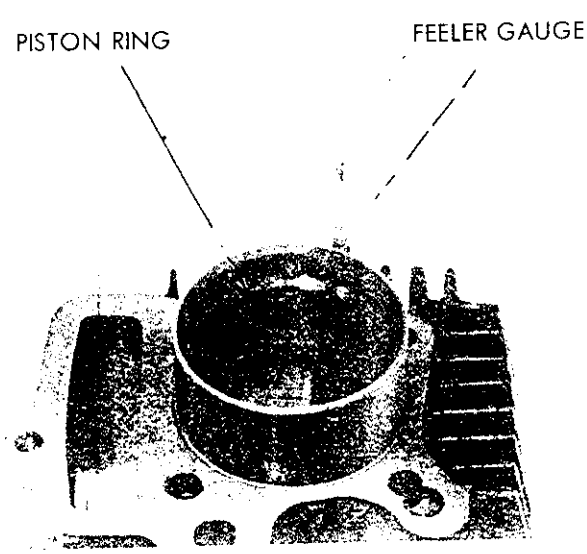
Measure the piston ring to groove clearance.

SERVICE LIMIT
TOP/SECOND: 0.12 mm



Remove piston rings and measure ring gap.

SERVICE LIMITS
TOP RING 0.5 mm
2ND RING 0.5 mm
OIL RING 1.1 mm

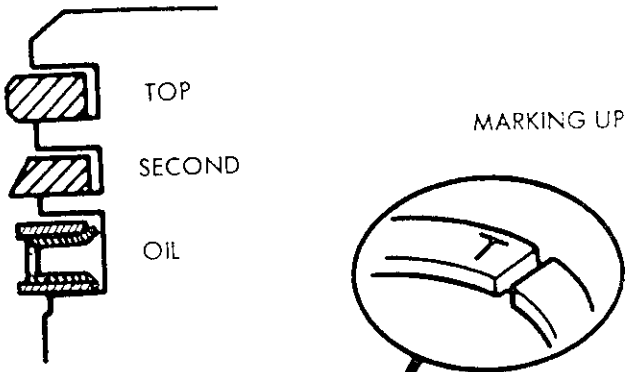


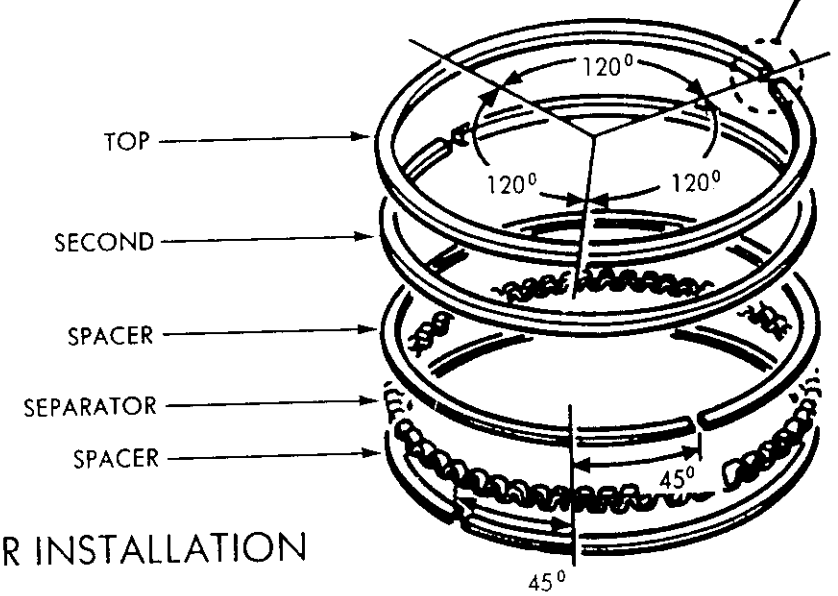
JOTE

Place ring squarely in cylinder and press it with piston to a depth of 30 mm.

;TON RING INSTALLATION

lean the piston ring grooves thoroughly.
ıstall the piston rings.
pace the piston ring gaps 120° apart.
ıstall the piston rings with the 'T' mark facing pwards.



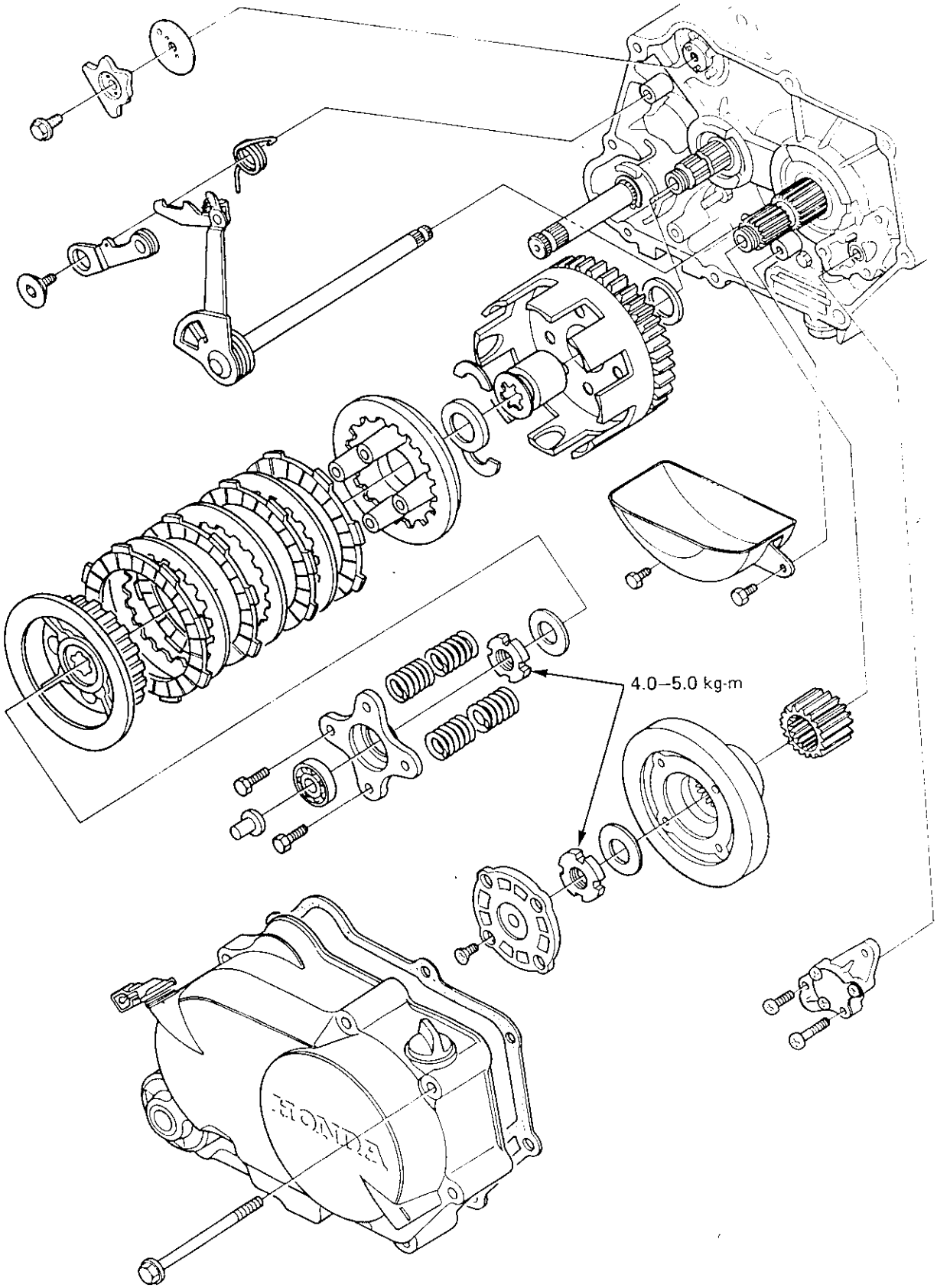


;TON/CYLINDER INSTALLATION

ıstall piston and cylinder in reverse order of dis-ıssembly.

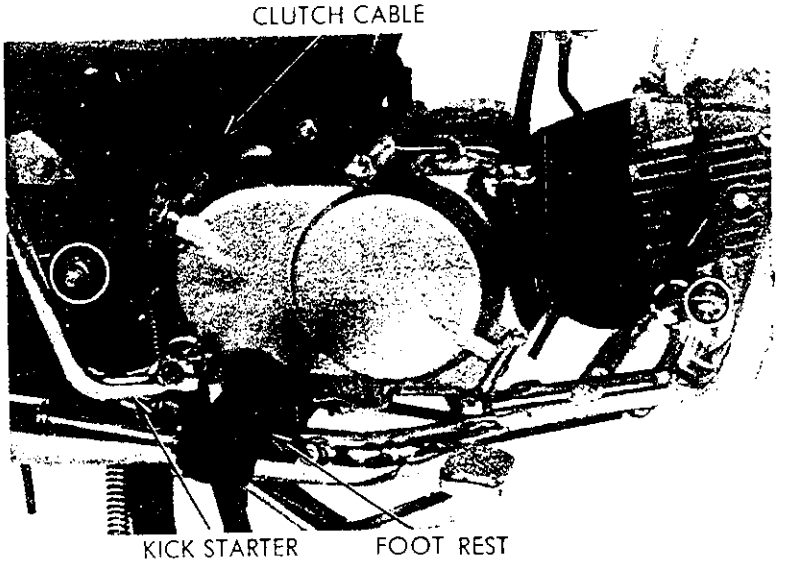
)TE

Position the 'IN' mark on piston towards inlet side.

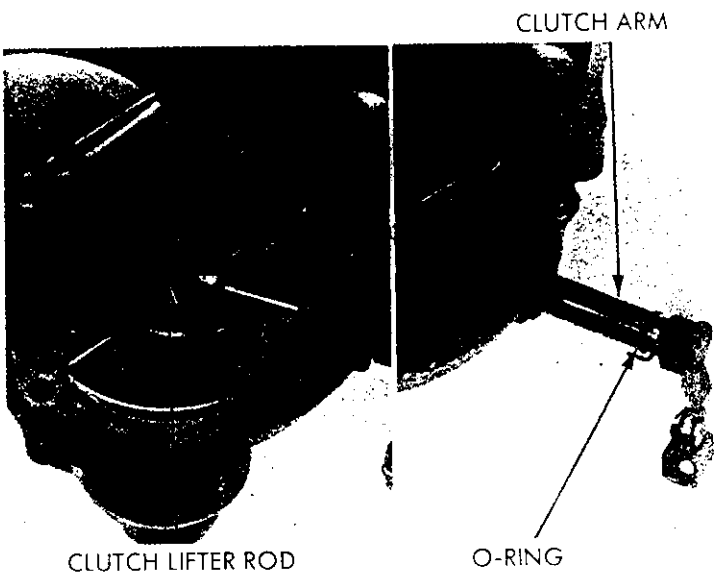

4.0–5.0 kg-m

CLUTCH

* Drain the engine oil.
* Remove the kick pedal.
* Remove exhaust muffler.
* Disconnect the clutch cable.
* Remove footrest and leg guard.
* Remove brake pedal spring.
* Loosen 8 bolts to remove the R. crank case cover.

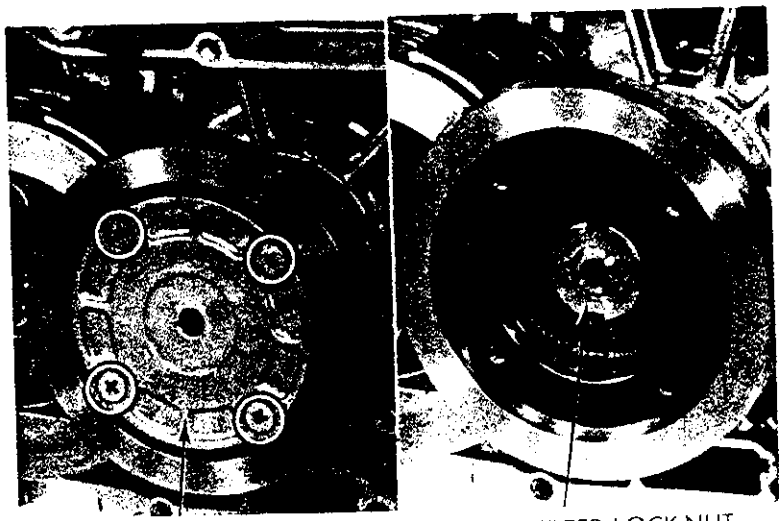


* Remove the clutch lifter rod and clutch arm. Check arm for wear or bending.



EMOVAL OF CLUTCH

Remove magnet cover.
Hold the magnet with universal holder.
Loosen the oil filter rotor screws.



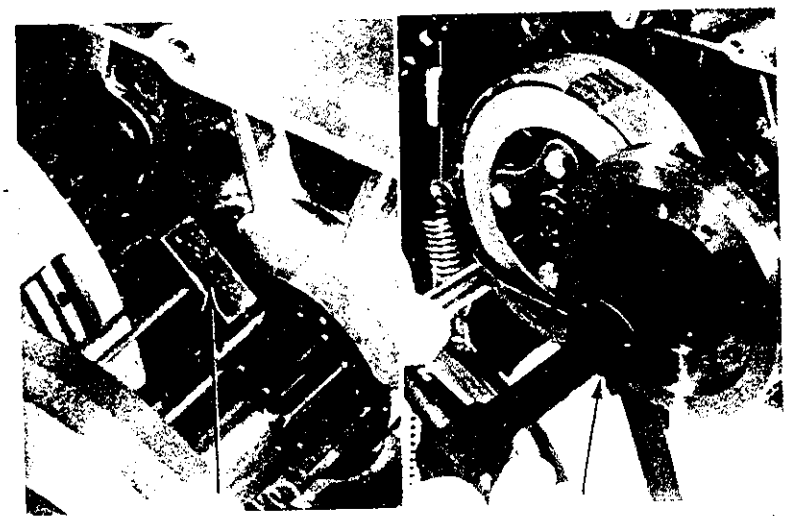
OIL FILTER ROTOR COVER

OIL FILTER LOCK NUT

Remove the oil rotor lock nut and washer using socket wrench 20 × 24

IOTE

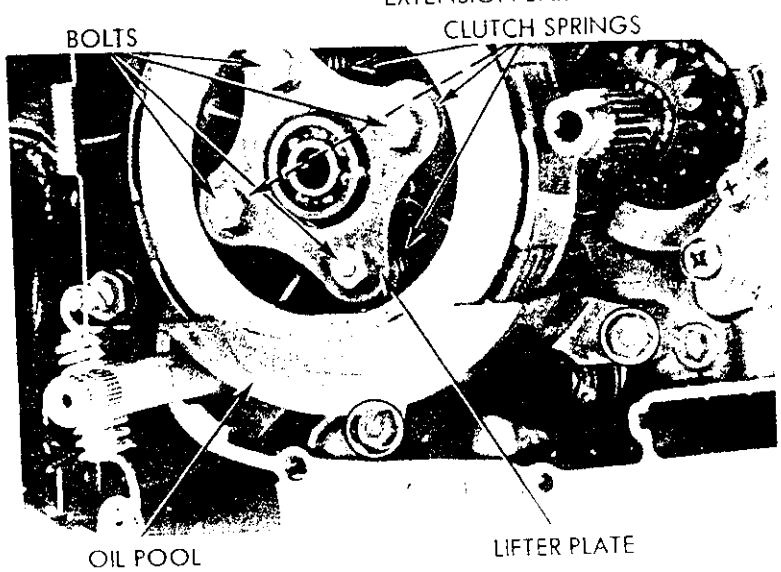
> Do not engage a screw driver between the gears as it may damage the profile.



GEAR HOLDER

LOCK NUT WRENCH (20×24mm)
EXTENSION BAR

- Remove oil pool.
- Remove the bolts on lifter plate.



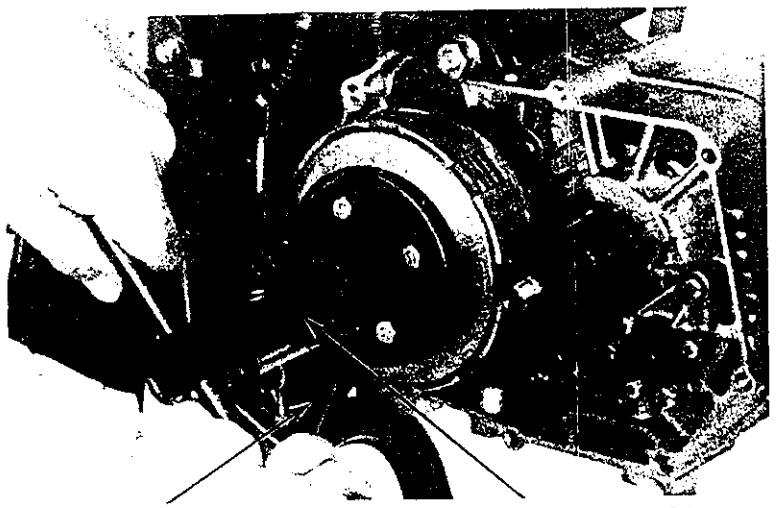
BOLTS

CLUTCH SPRINGS

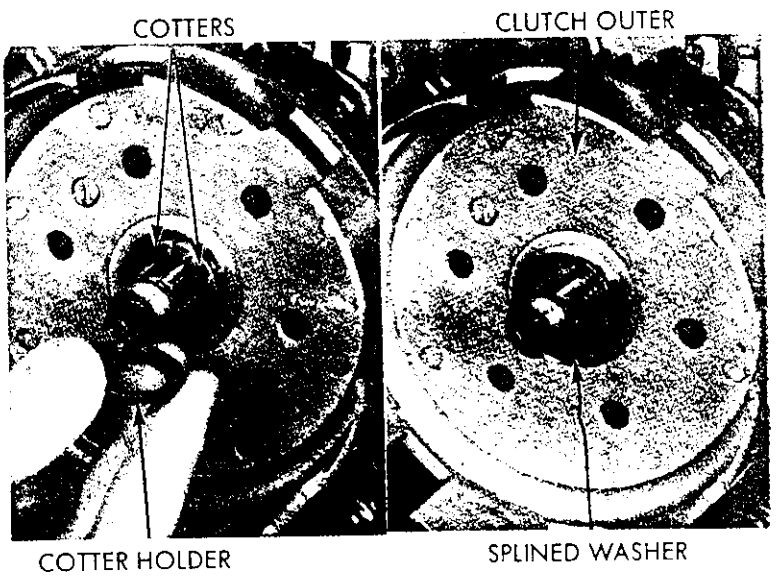
OIL POOL

LIFTER PLATE

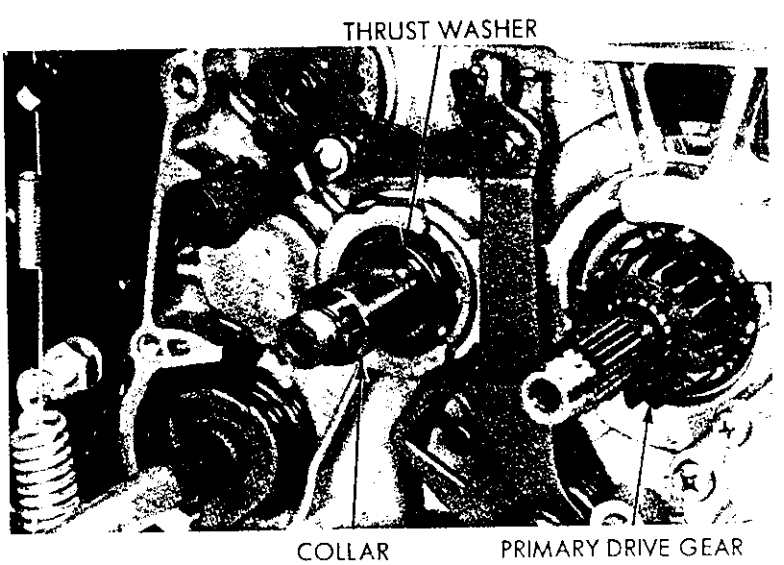
* Hold the clutch using clutch centre holder and loosen the clutch lock nut.
* Remove the lock washer.
* Remove the clutch plates and discs.



* Remove cup washer, cotters and splined washer.
* Remove the clutch outer drum.



* Remove the collor and thrust washer.
* Remove the primary drive gear.

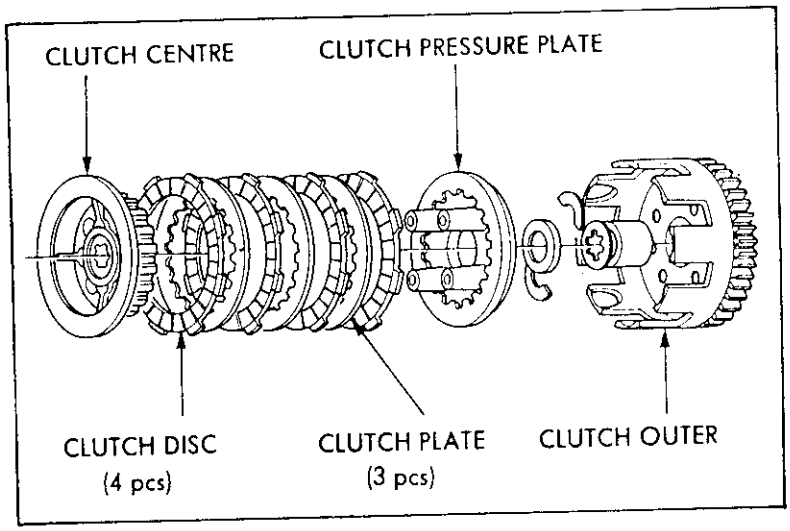


NSTALLATION OF CLUTCH

Inspect all parts for wear.
Assembly is in reverse order of disassembly.

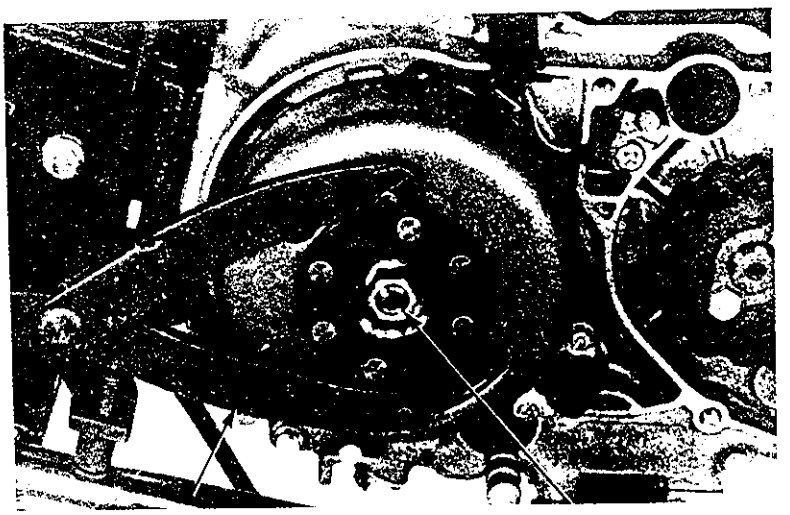
NOTE

Install lock washer with the word OUTSIDE/ O facing towards you.



M CHAIN/TENSIONER CHANISM

nove the gear shift pedal.
nove the magnet cover.
ld the magnet with universal holder and remove nut.

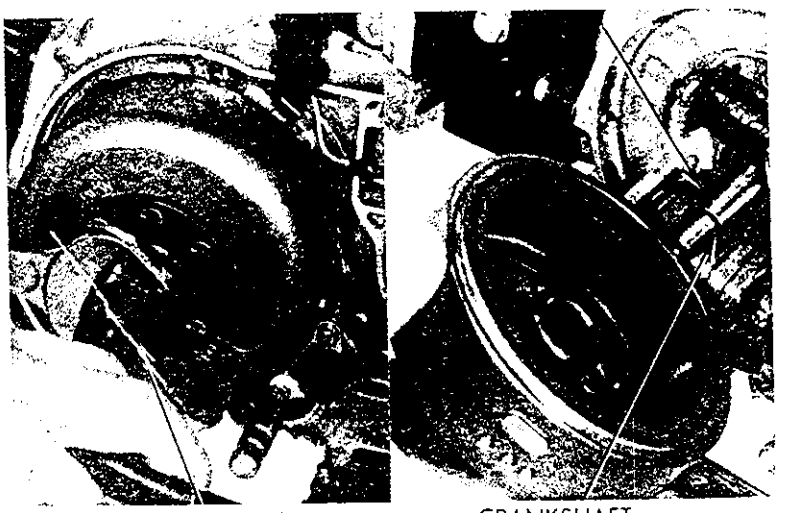


UNIVERSAL HOLDER

10mm NUT

WOODRUFF KEY

nove the magnet using magnet puller.
ain the engine oil.



FLYWHEEL PULLER

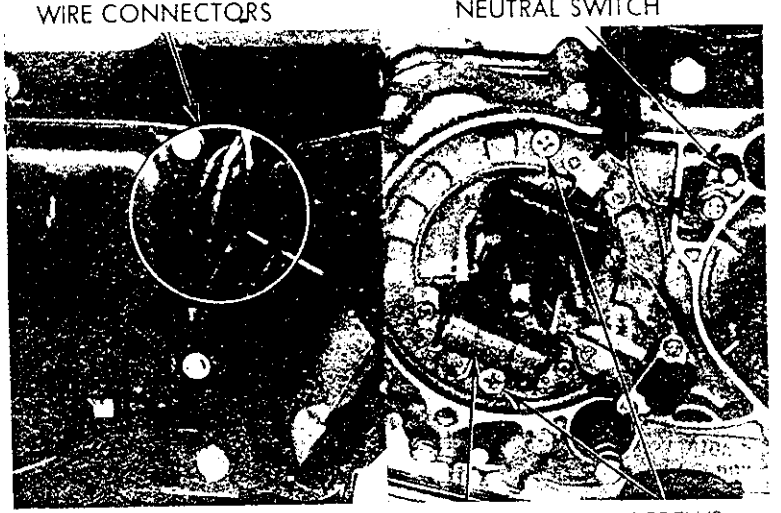
CRANKSHAFT

A.C. GENERATOR WIRE CONNECTORS

NEUTRAL SWITCH

connect the stator plate wiring connections.
nove the stator plate screws.

h rod removal
nove the tensioner bolt and sealing washer care-
y so that spring does not fly out.



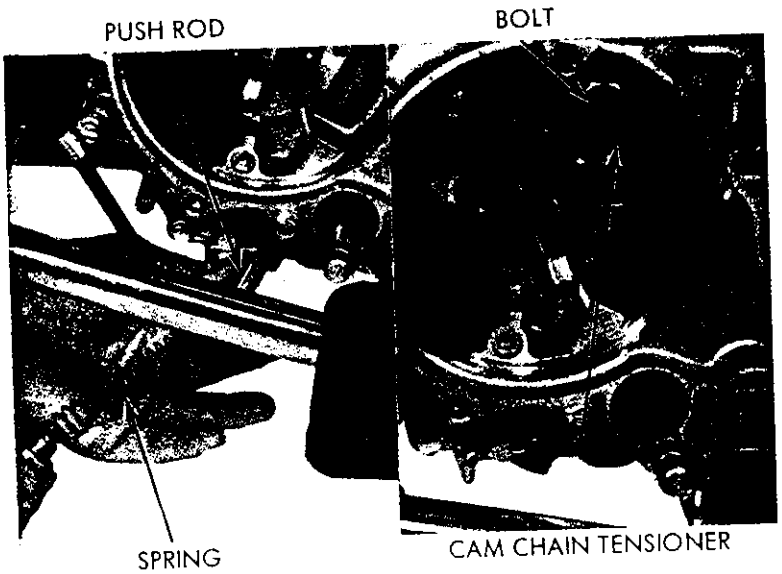
STATOR

SCREWS

'emove the push rod and check for clogging.

)TE

To check the valve, suck air through it by mouth. If it allows air in both directions then valve is defective.



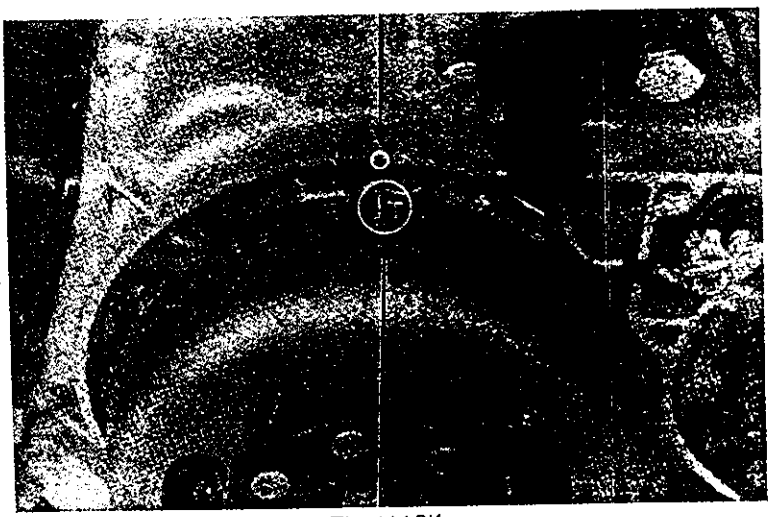
REMOVAL OF CAM CHAIN

Remove cylinder head.
Remove guide rollor.
.ift off the cam chain from the drive sprocket.
Check rollor pins for wear.

INSTALLATION OF CAM CHAIN

nstall cam chain on drive sprocket.
.ift cam chain through the chamber in cylinder.
Rail the guide rollor on cam chain and tighten guide
rollor bolt.

nstall the stator plate.
it magnet and allign the 'T' mark with notch on
. Crank Case as shown.



'T' MARK

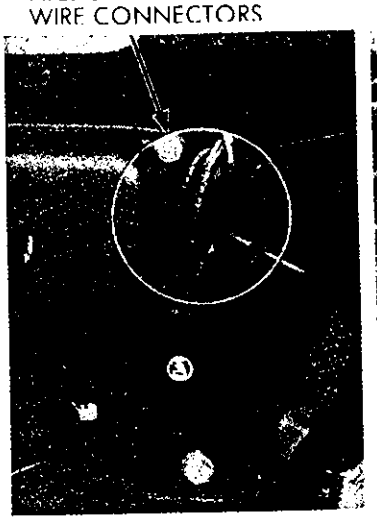
nstall cam chain sprocket in the cam chain.
nstall cylinder head.

IOTE

Make sure that O mark on cam sprocket is alligned with notch on cylinder head.

Connect the wires of stator plate.
nstall the magnet cover.

A.C. GENERATOR WIRE CONNECTORS

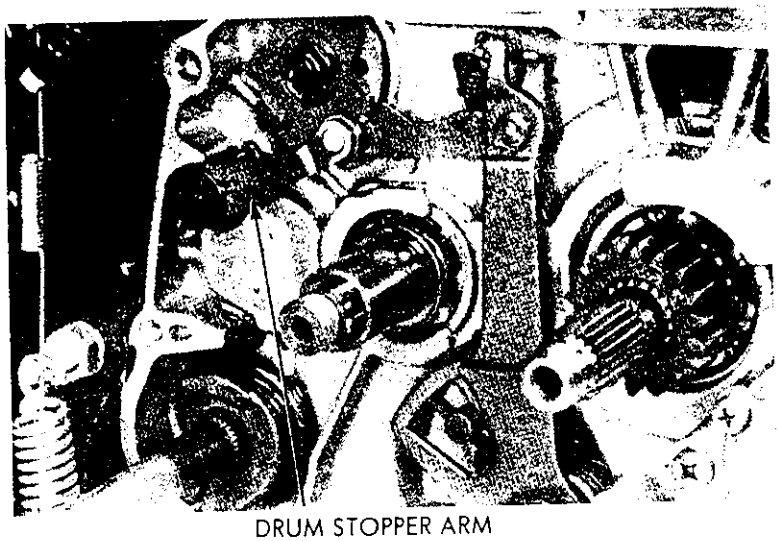


NEUTRAL SWITCH

STATOR SCREWS

EAR SHIFT MECHANISM

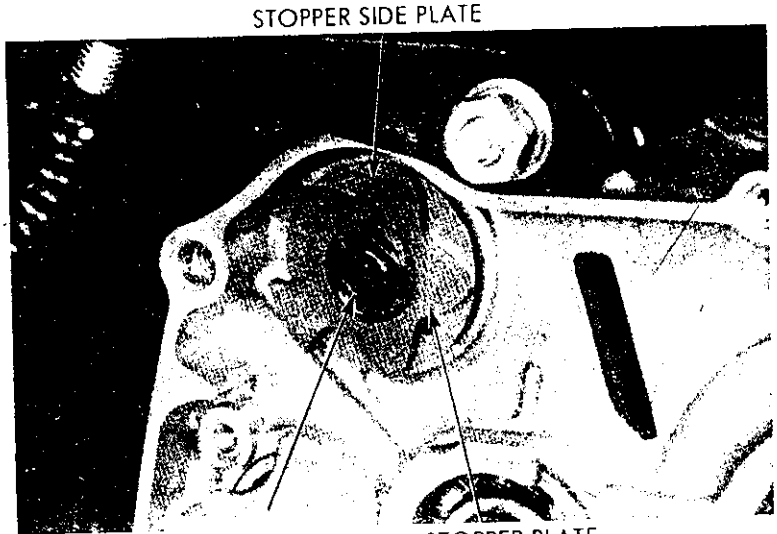
Remove oil rotor filter.
Remove the clutch.
Remove gear shift pedal.
Pull out the gear shift spindle.
Remove drum stopper arm.



DRUM STOPPER ARM

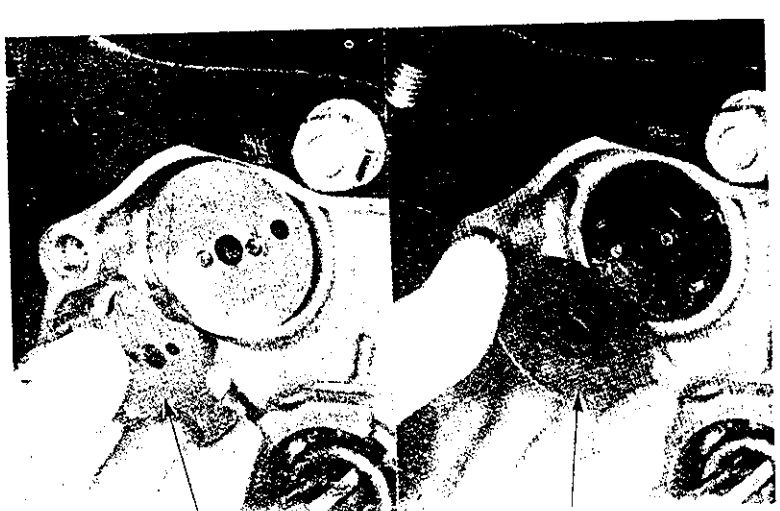
STOPPER SIDE PLATE

emove the bolt as shown in photograph.



BOLT DRUM STOPPER PLATE

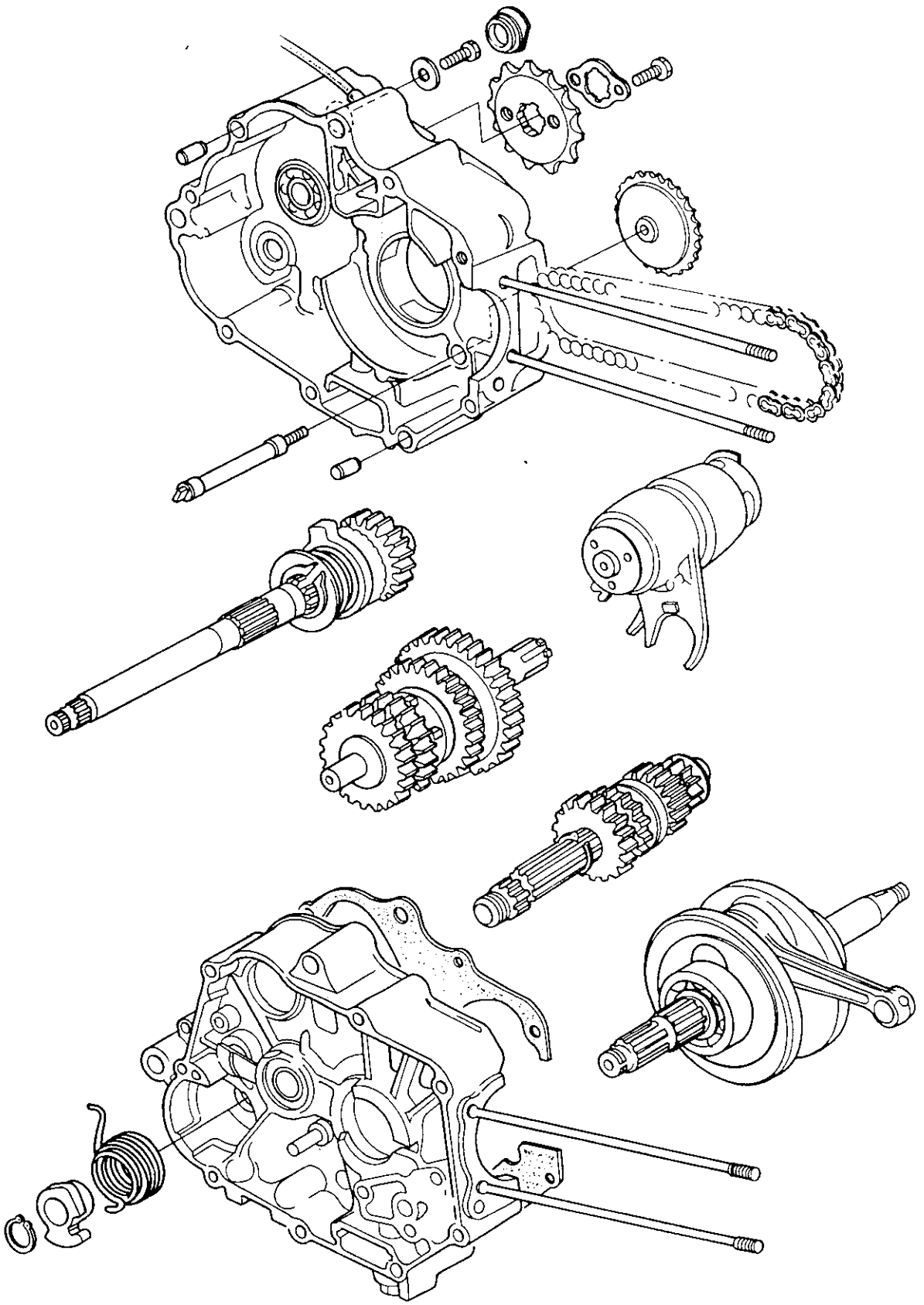
Remove drum stopper plate and side plate.



STOPPER SIDE PLATE STOPPER PLATE

SEMBLY OF GEAR SHIFT MECHANISM

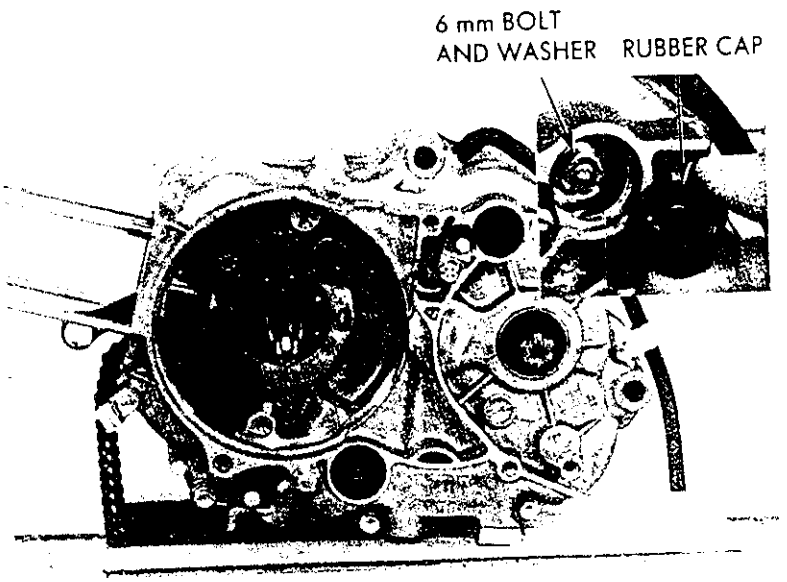
Assembly is in reverse order of disassembly.



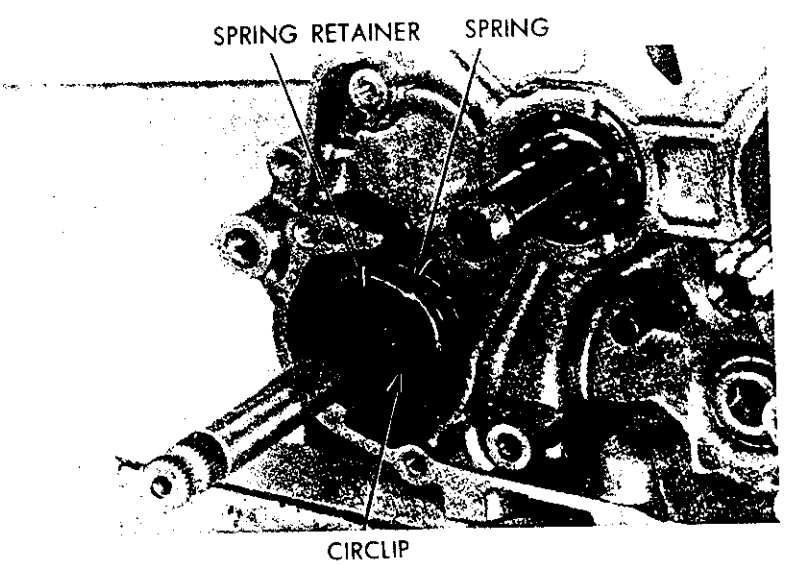
RANKCASE SEPARATION

!emove cylinder head.
?emove cylinder and piston.
!emove clutch, primary gear drive and gear shift
inkage.
)ismount engine from chassis frame.

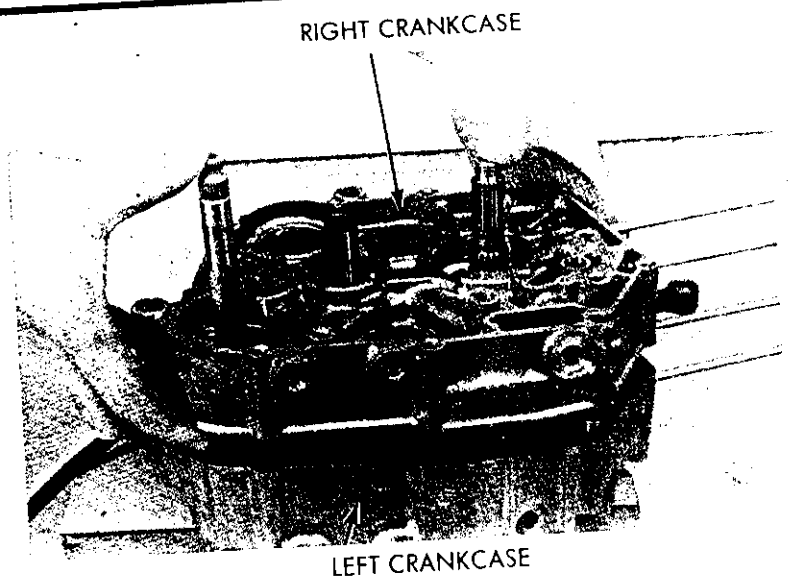
.oosen the drum bolt after removing rubber cap.
>lace the engine with L. Crank Case facing upwards.
?emove the bolts attaching the crank case.



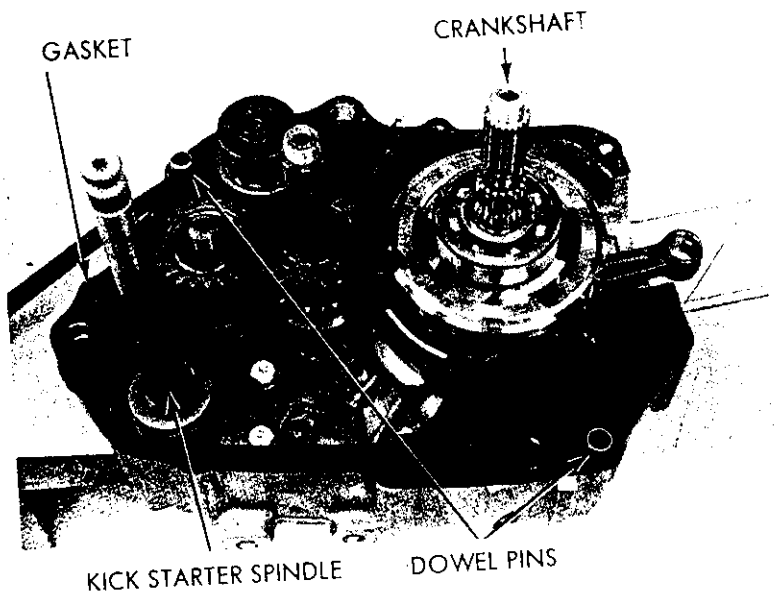
Remove the circlip on kick starter.
Remove the kick spring retainer and the spring.



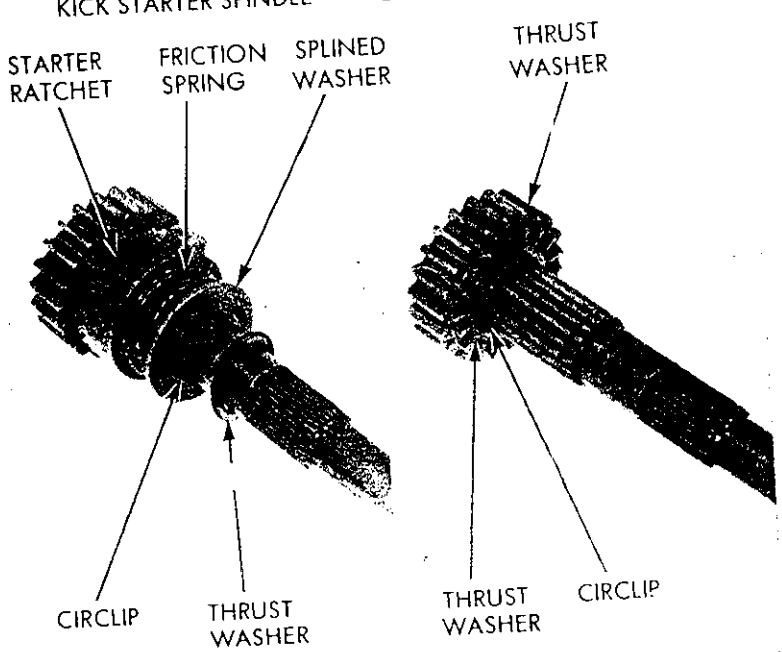
arate the crank case.



t out the crank shaft/kick stater/gears.

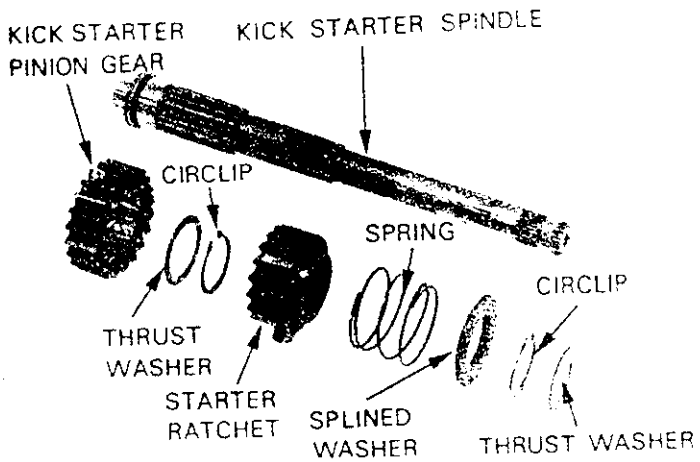


SASSEMBLY OF KICK STARTER SPINDLE
Remove the thrust washer and take out the circlip.
Remove the spline washer, spring and ratchet.



ASSEMBLY OF KICK STARTER SPINDLE

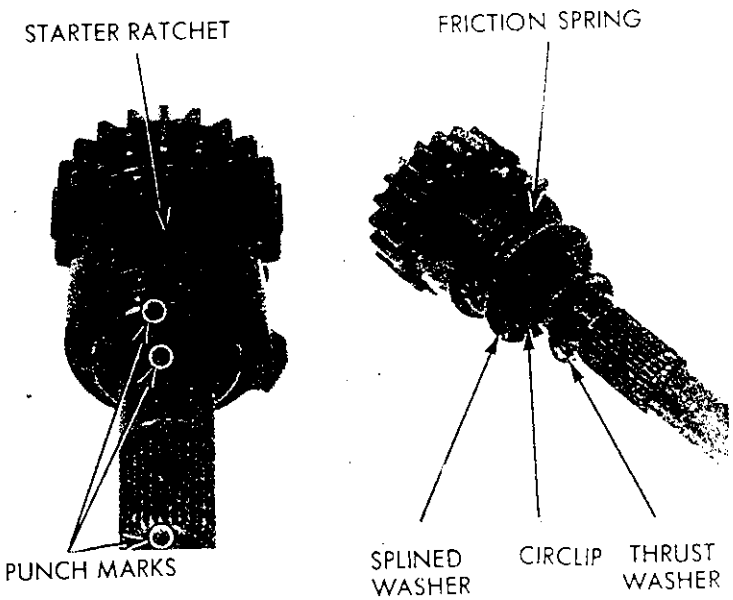
- Assembly is in reverse order of disassembly.



NOTE

Install the starter ratchet on the spindle alligning the punch marks on the ratchet and spindle.

- Install the spring and spline washer.
- Install circlip and thrust washer.

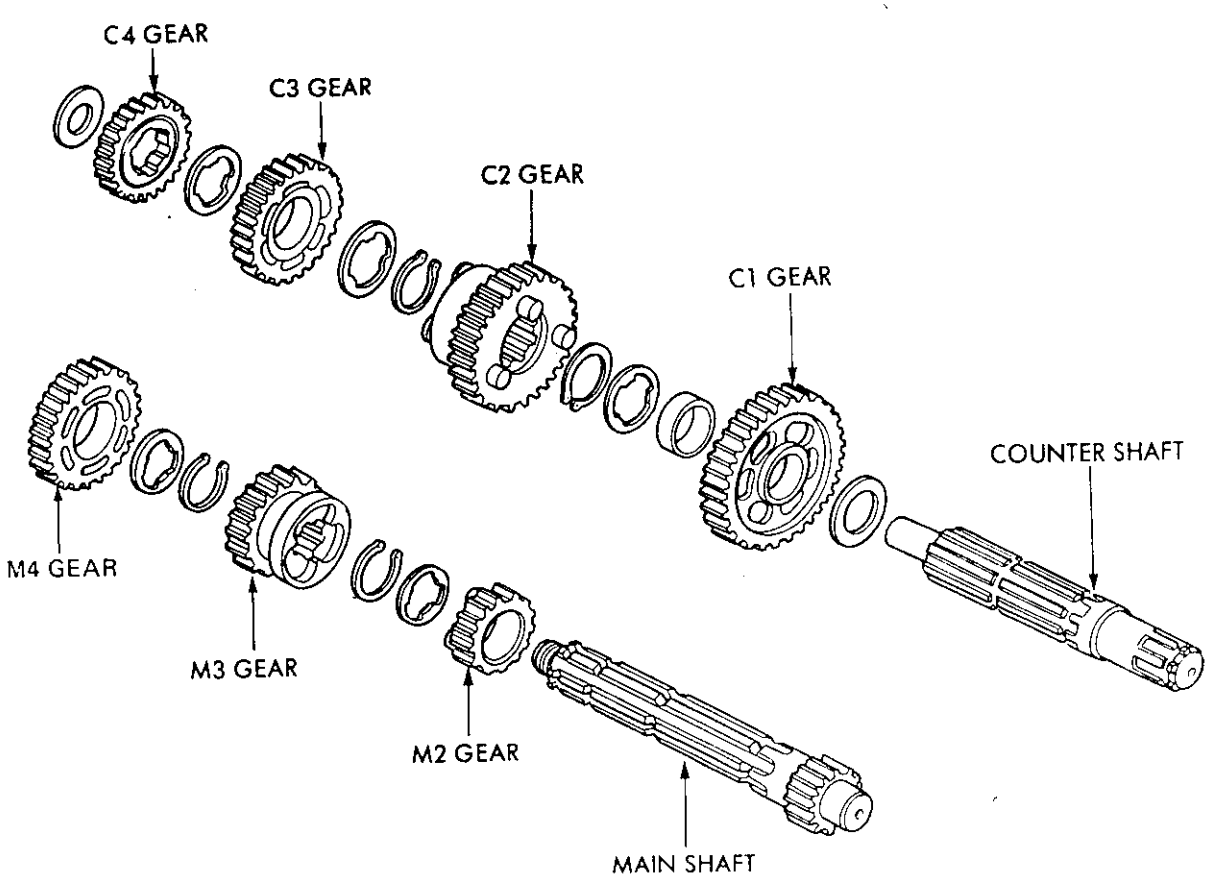


ASSEMBLY OF NSMISSION

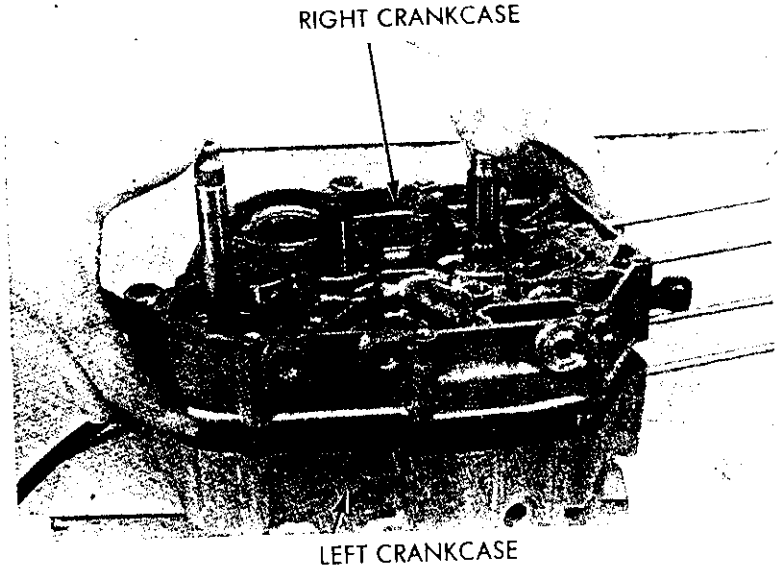
ove the transmission alongwith shift drum.
ove all gears and washers.

EMBLY OF TRANSMISSION

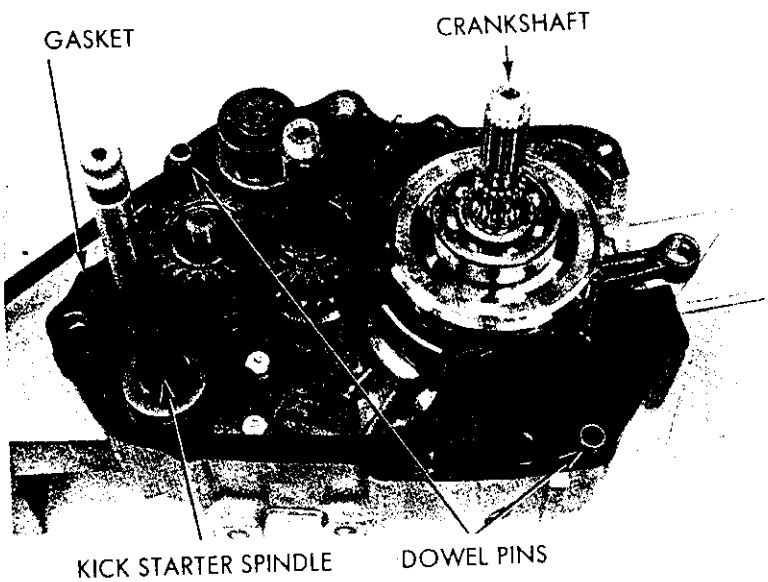
mbly will be as shown in figure.



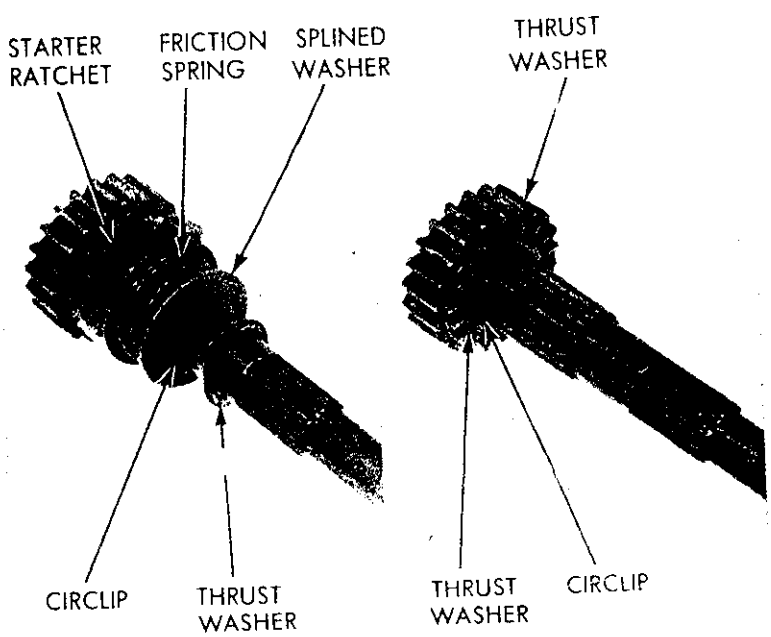
parate the crank case.



it out the crank shaft/kick stater/gears.

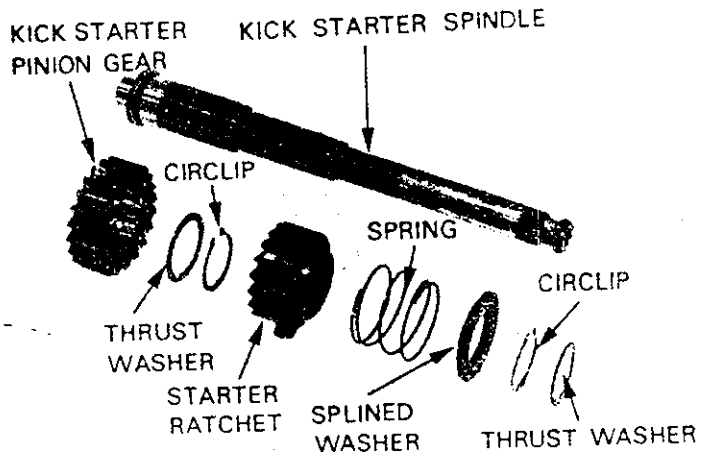


ASSEMBLY OF KICK STARTER SPINDLE
emove the thrust washer and take out the circlip.
emove the spline washer, spring and ratchet.



ASSEMBLY OF KICK STARTER SPINDLE

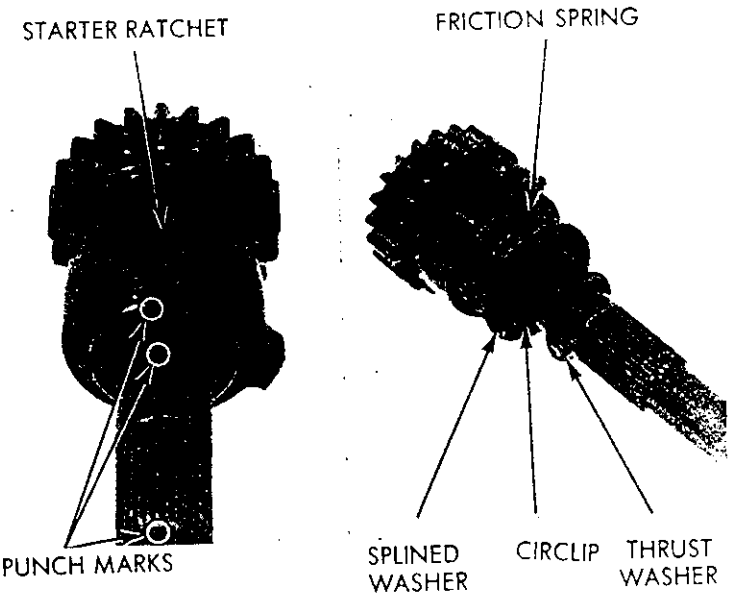
Assembly is in reverse order of disassembly.



NOTE

Install the starter ratchet on the spindle alligning the punch marks on the ratchet and spindle.

Install the spring and spline washer.
Install circlip and thrust washer.

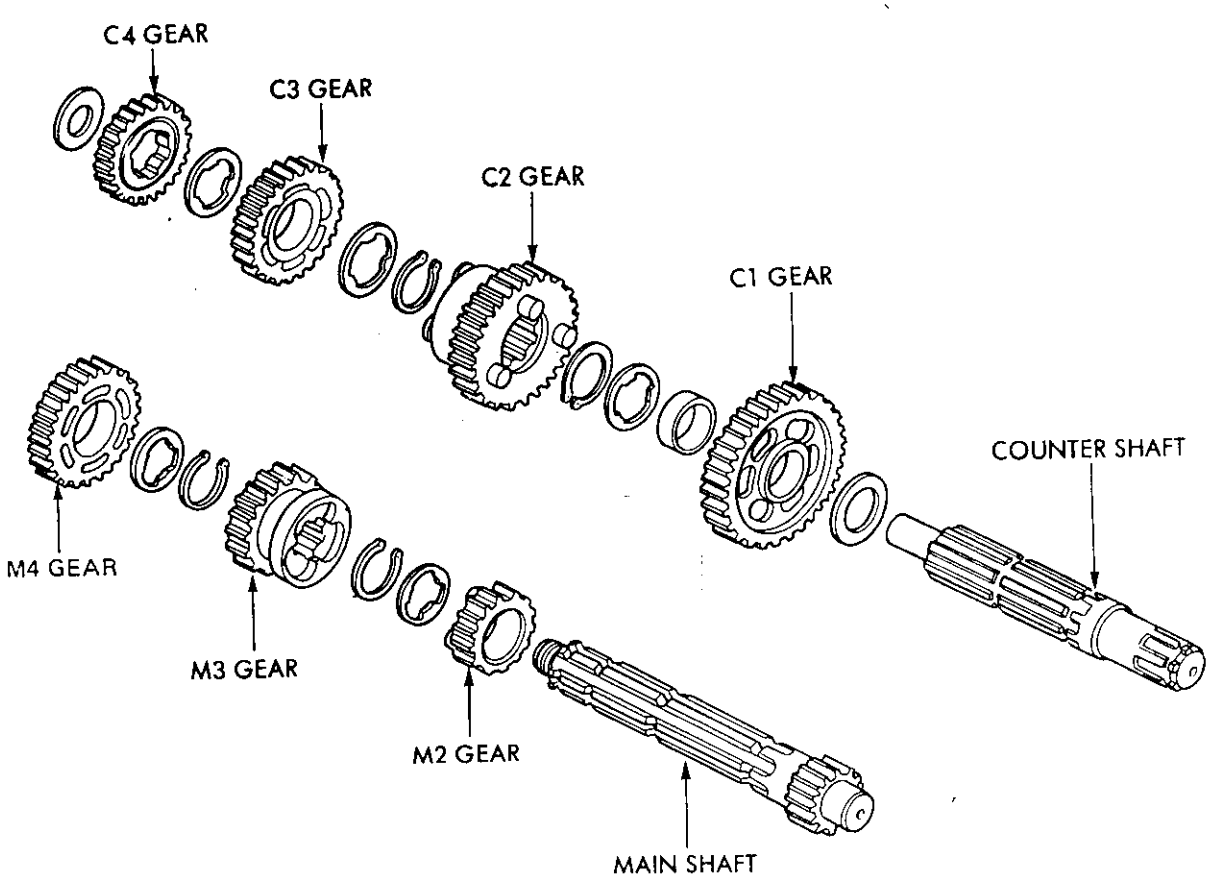


ISASSEMBLY OF
ANSMISSION

emove the transmission alongwith shift drum.
emove all gears and washers.

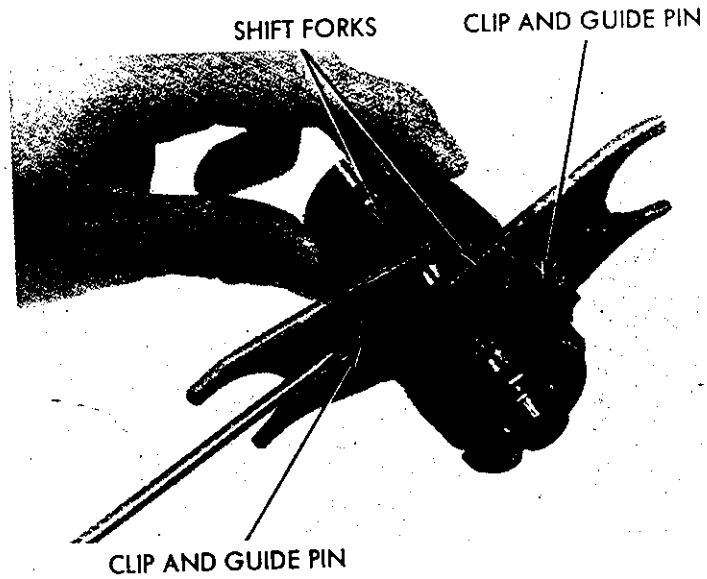
SSEMBLY OF TRANSMISSION

Assembly will be as shown in figure.



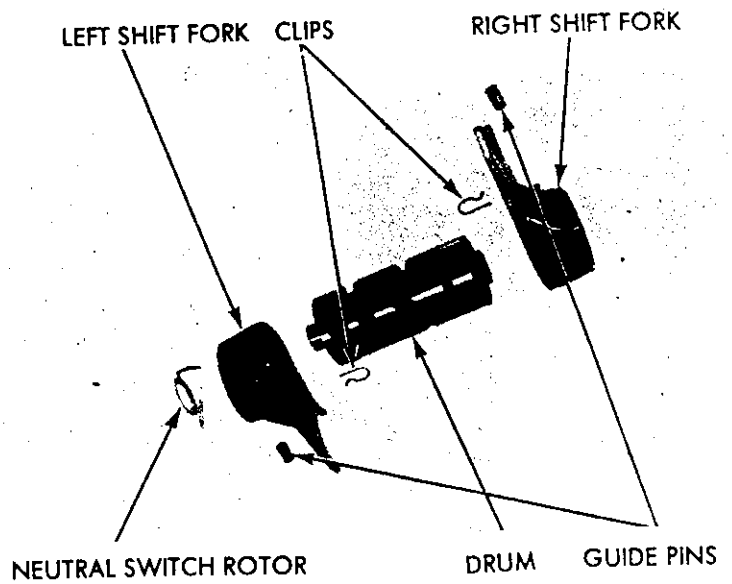
SHIFT DRUM DISASSEMBLY

* Pull out the clip and shift fork guide pin.
* Remove the forks and inspect for wear.



SHIFT DRUM ASSEMBLY

* Assembly will be in reverse order of disassembly.

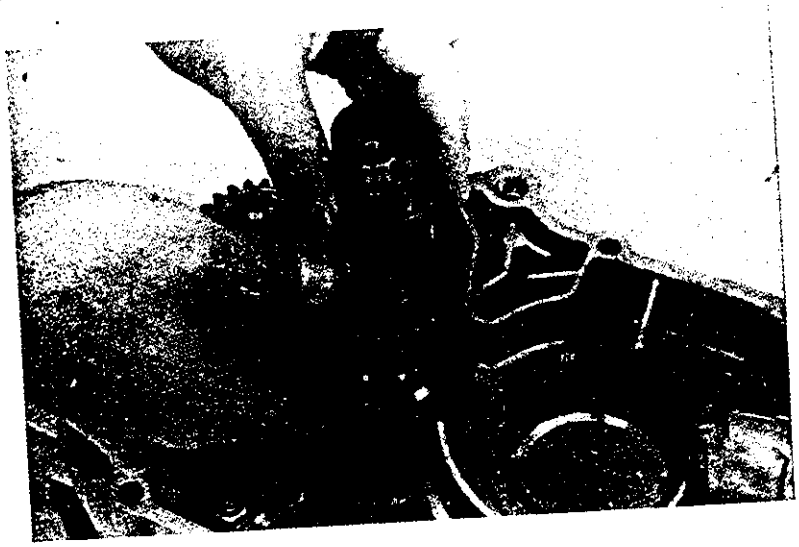


STALLATION OF ANSMISSION

TE

Apply engine oil to all gears.

ssemble counter shaft and main shaft.
ıstall gear shift drum and transmission assy. in the . Crank Case.

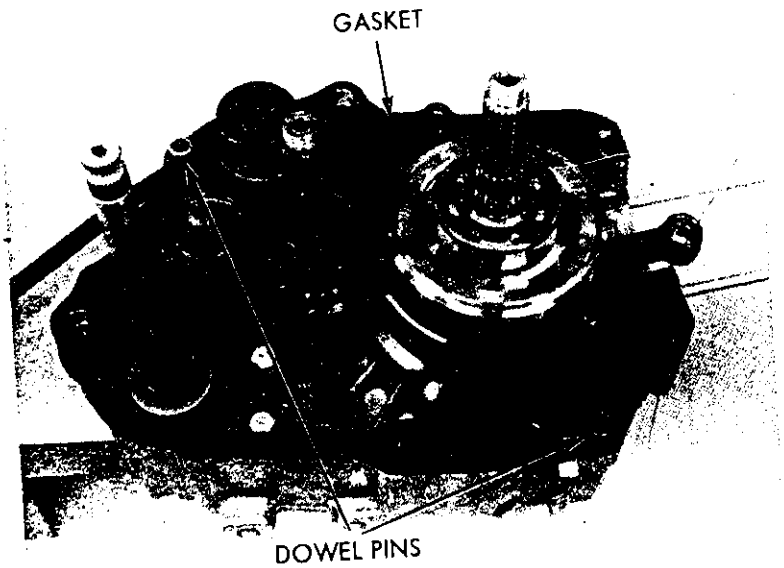


nstall the Kick Starter and crank shaft in the .. Crank Case.
nstall the R. Crank Case on the L. Crank Case.

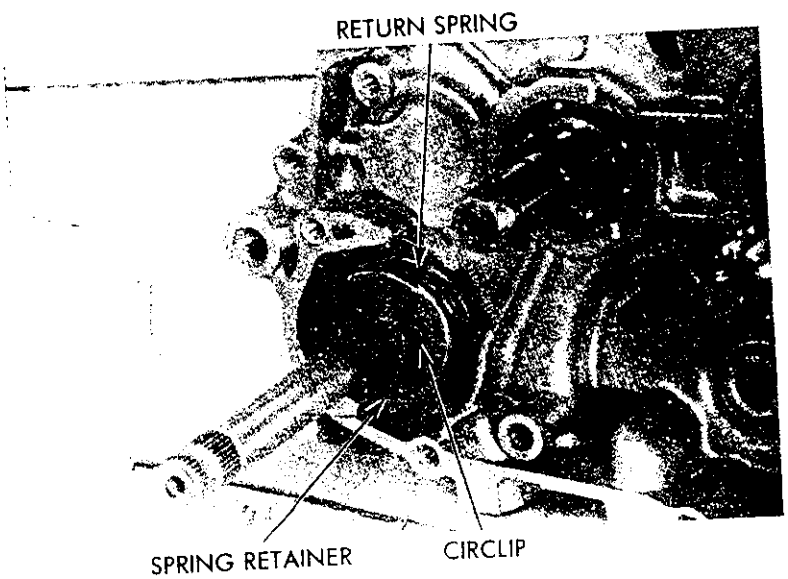
)TE

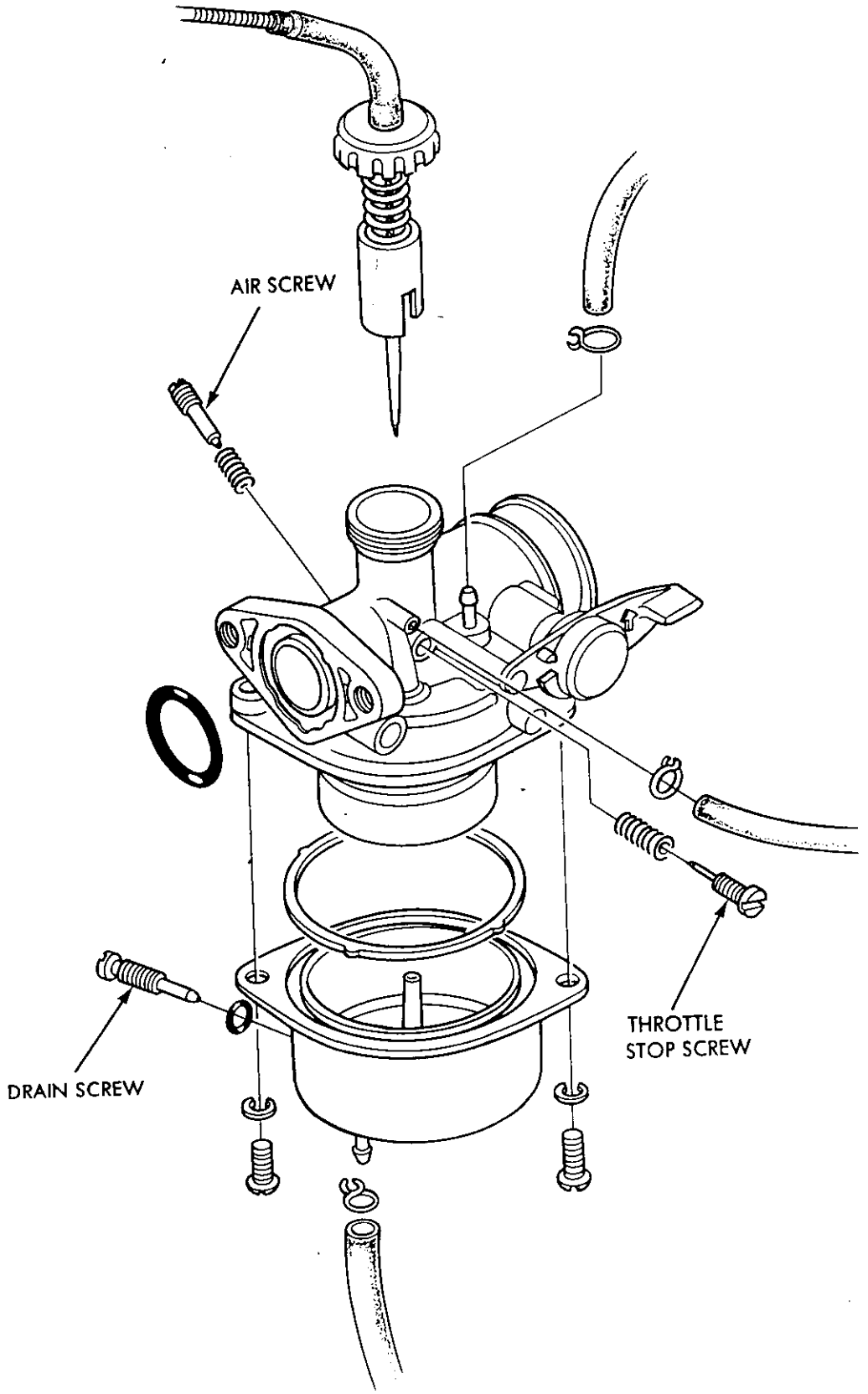
Rotate the oil pump sprocket so that drive spindle seats properly in oil pump.

Tighten the drum bolt.



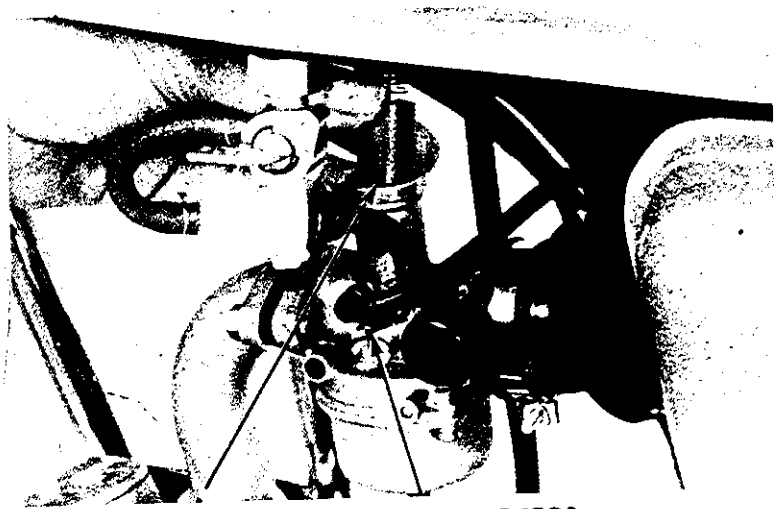
Install the kick starter spring and retainer on the kick starter.
Install the circlip.
Assemble clutch, primary drive gear, gear shift linkage and clutch cover.
Mount starter plate and magnet.
Assemble cylinder, piston and cylinder head.



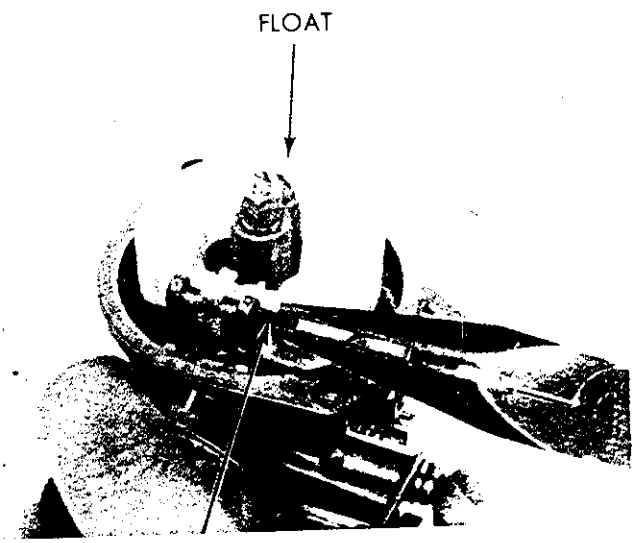

AIR SCREW
DRAIN SCREW
THROTTLE
STOP SCREW

SASSEMBLY OF ARBURETTOR

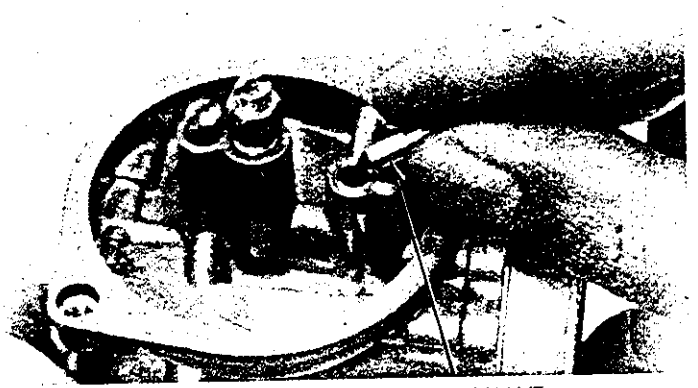
urn off petrol tank and disconnect the fuel line.
emove carburettor top with throttle valve.
oosen carburettor band screw and inlet pipe bolts.



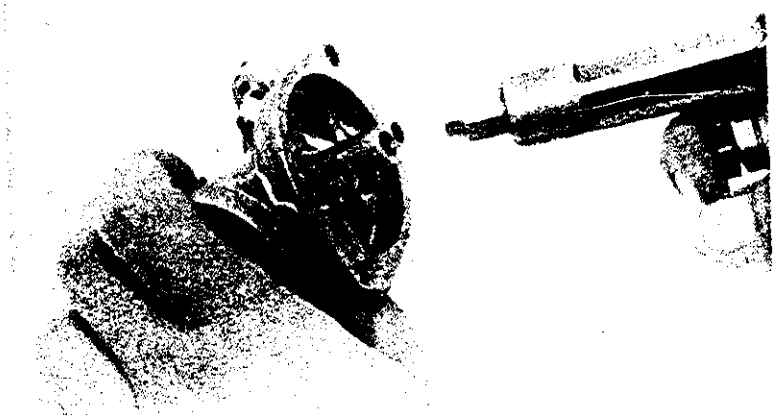
emove the float chamber body.
ull out float pin.



!emove float and float valve and inspect for wear.

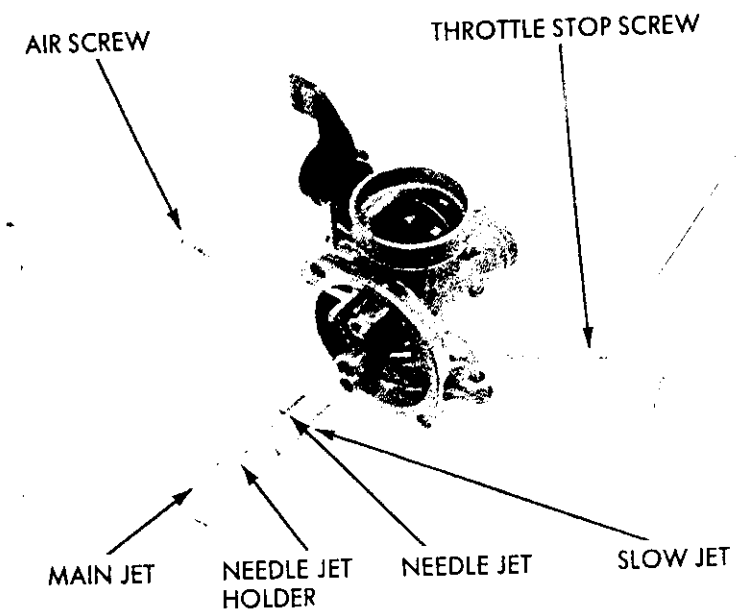


emove main jet, slow jet and slow jet holder.
emove air screw.
emove idling screw.
low all jets and body opening with comprest air.



SSEMBLY OF CARBURETTOR

ssembly is in reverse order of disassembly.

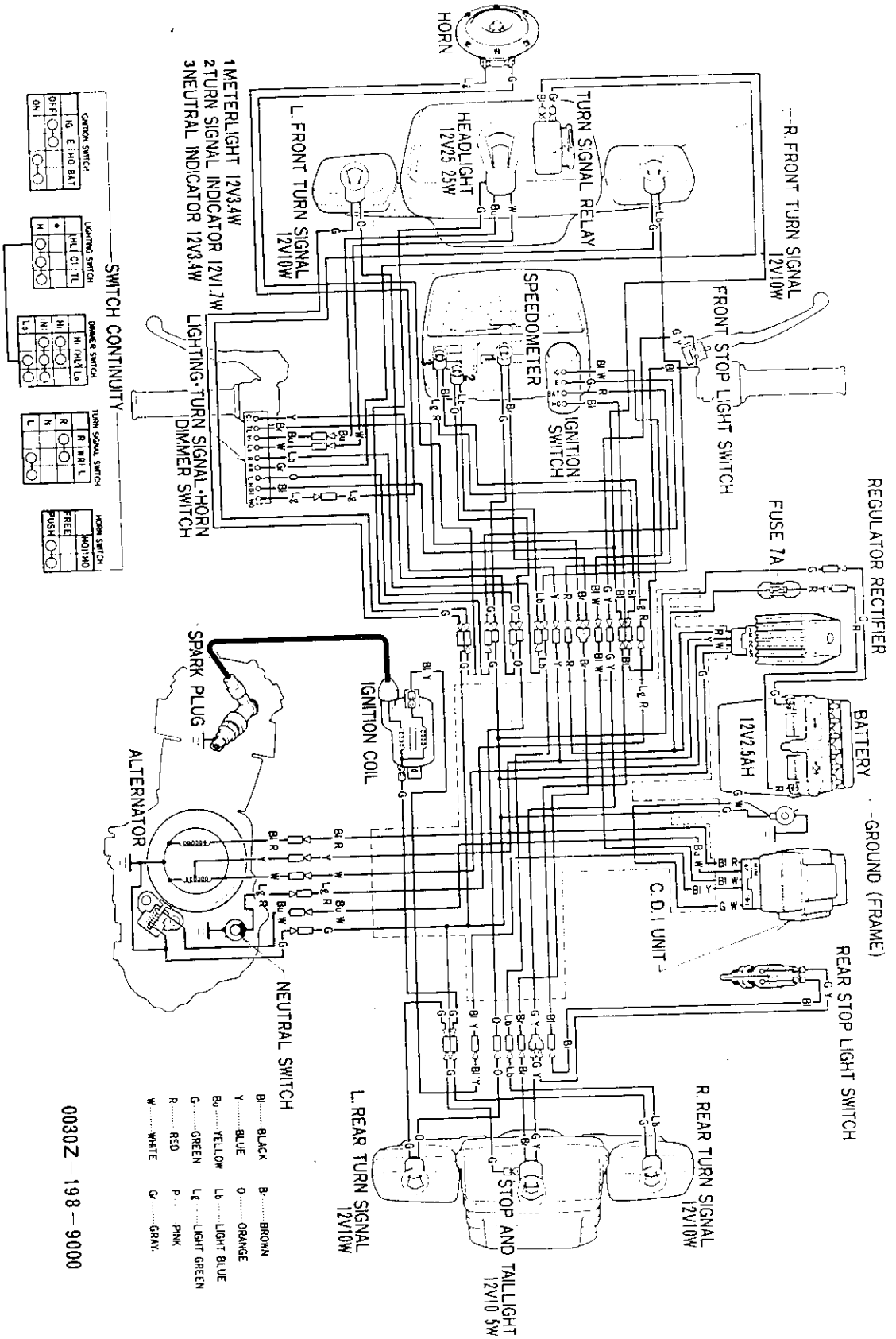


DJUSTMENT OF IR SCREW/MIXTURE SCREW

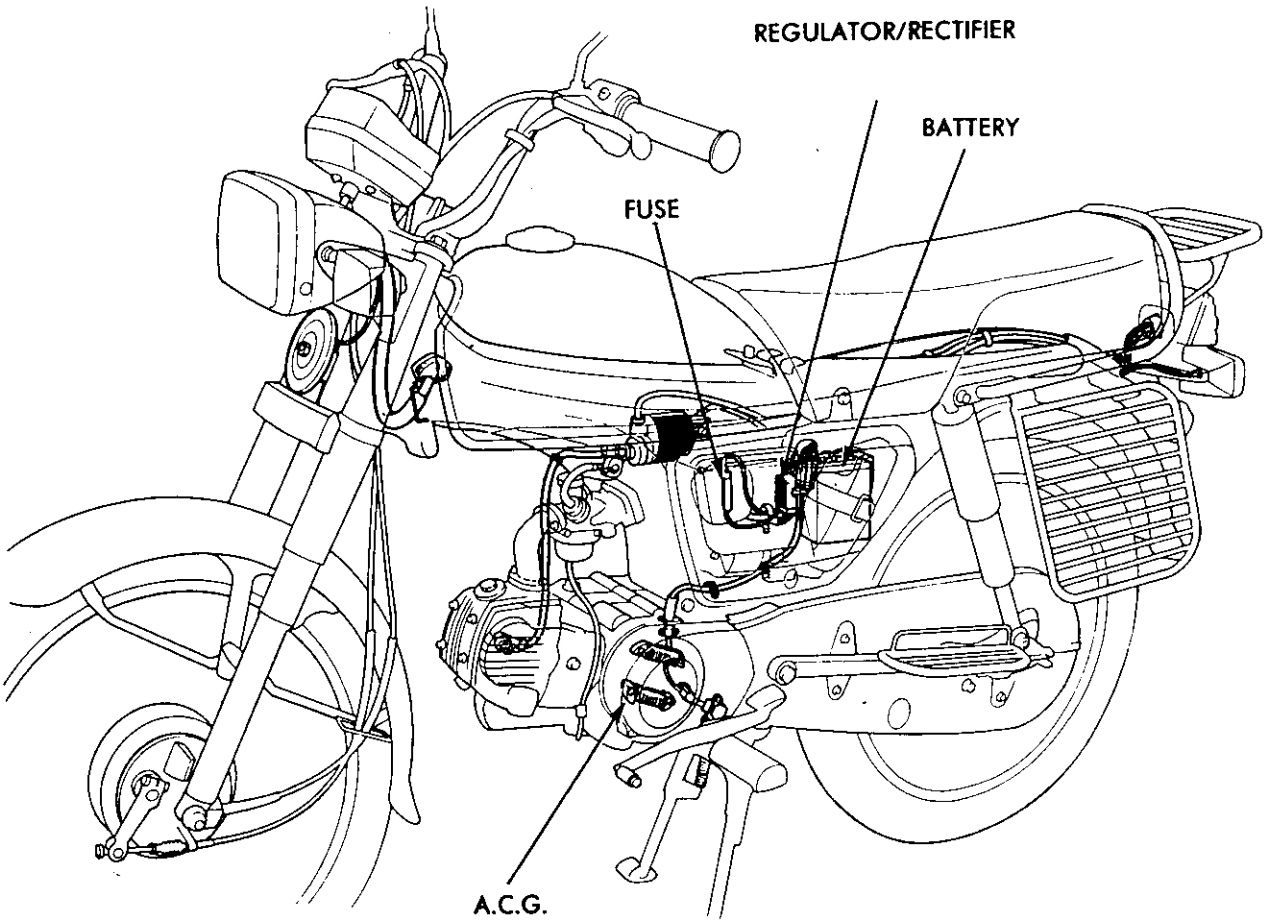
tart the vehicle and let engine warm up.
ncrease idling speed to about 1600 rpm.
et air screw at 1 turn (at 360° from full tight position).
tart opening the air screw. Set it at peak rpm.
\djust the idle screw to set engine rpm at 1400 ± 00 rpm.

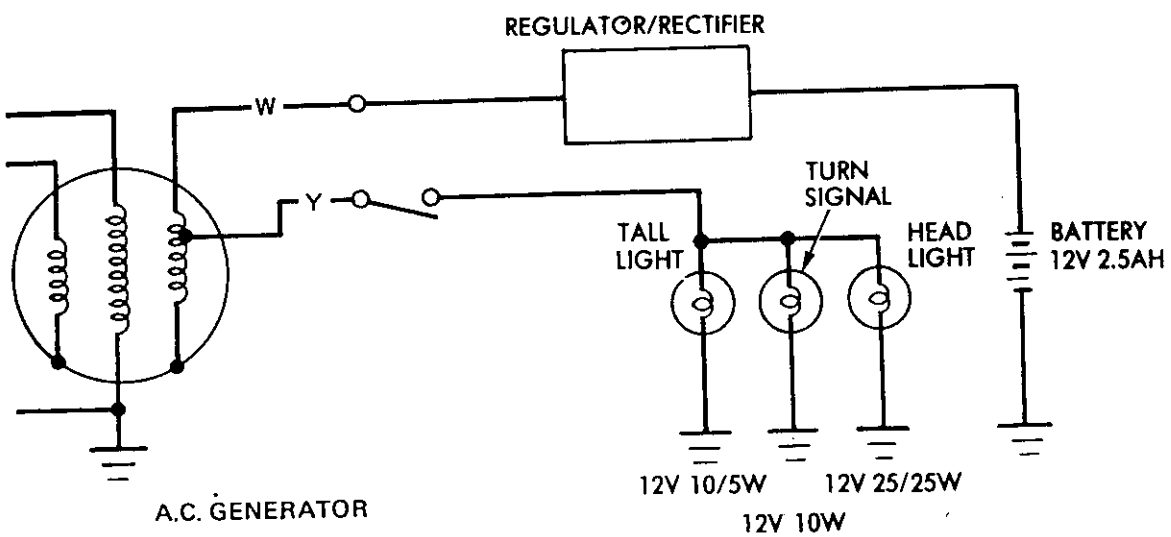
)

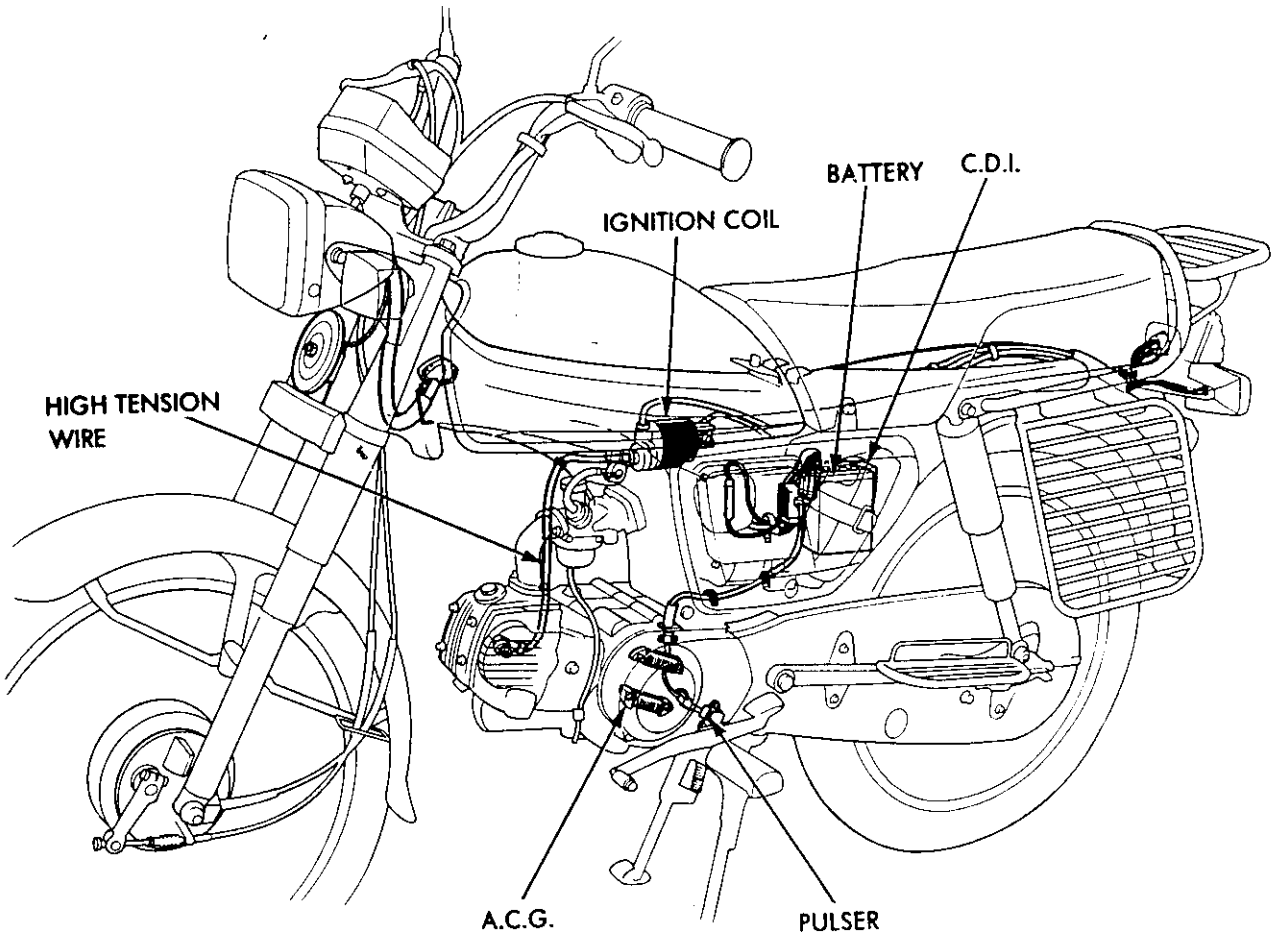
VIRING DIAGRAM

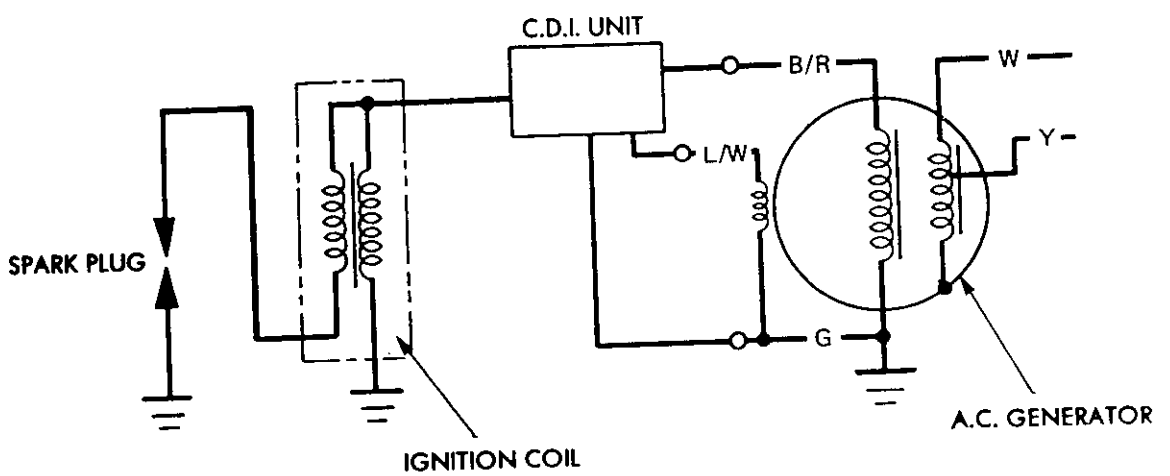


0030Z-198-9000


REGULATOR/RECTIFIER
BATTERY
FUSE
A.C.G.


REGULATOR/RECTIFIER
W
Y
TURN
SIGNAL
TALL
LIGHT
HEAD
LIGHT
BATTERY
12V 2.5AH
12V 10/5W
12V 25/25W
12V 10W
A.C. GENERATOR


BATTERY
C.D.I.
IGNITION COIL
HIGH TENSION
WIRE
A.C.G.
PULSER


C.D.I. UNIT
B/R
W
L/W
Y
SPARK PLUG
G
A.C. GENERATOR
IGNITION COIL

'IRING COLOUR CODES

'ATOR PLATE

Excitor coil to CDI Unit — Black/Red
Pulser coil to CDI Unit — White
Charging coil to R.R. Unit — White
Lighting coil to R.R. Unit — Yellow
Neutral switch to neutral light — Green/Red
All earth wires — Green
CDI Unit to primary ignition — Black/Yellow
CDI Unit to ignition switch — Black/White
CDI Unit to earth — Green/White
R.R. Unit to battery — Red
gnition switch to main line — Black
Switch assy. winker to headlight (high beam) — Blue
Switch assy. winker to headlight (low beam) — White
Switch assy. winker to left winker — Orange
Switch assy. winker to right winker — Light Blue
Stop light switch to brake light — Green/Yellow
Switch assy. winker to speedometer light — Brown
Switch assy. winker to tail light — Brown
Turn signal relay to switch assy. winker — Gray
Switch assy. winker to Horn — Light Green

STATOR PLATE

1. Excitor coil = 225-465 Ohm
2. Pulser coil = 50-170 Ohm
3. Charging coil = 0.6-1.4 Ohm
4. Lighting coil = 0.3-1.0 Ohm

IGNITION COIL

1. Primary = 0.2-0.8 Ohm
2. Secondary = 8-15 Kilo Ohm

RECTIFIER COMP. REGULATOR

(+) / (−)	WHITE	YELLOW	RED	GREEN
WHITE		∞	3-50	∞
YELLOW	∞		∞	5-100
RED	∞	∞		∞
GREEN	∞	5-100	∞	

(ALL READINGS ARE IN KILO OHM)

ENGINE DOES NOT START OR IS DIFFICULT TO START
ENGINE LACKS POWER
POOR PERFORMANCE AT LOW AND IDLE SPEEDS
POOR PERFORMANCE AT HIGH SPEEDS
POOR HANDLING

NGINE DOES NOT START OR IS DIFFICULT TO TART

Probable Cause

Check if fuel is getting to carburettor

NOT GETTING TO CARBURATTOR →
(1) No fuel in fuel tank
(2) Clogged fuel tube or fuel filter
(3) Sticky float valve
(4) Clogged fuel tank cap breather tube.

GETTING TO CARBURETTOR

↓

Type spark test

WEAK OR NO SPARK →
(1) Faulty spark plug
(2) Fouled spark plug
(3) Faulty C.D.I. unit
(4) Broken or short high tension cord.
(5) Faulty A.C. generator
(6) Broken or short ignition coil
(7) Faulty pulse generator
(8) Poorly connected, broken or short wires

GOOD SPARK

Test cylinder compression

LOW COMPRESSION →
(1) Kick pedal slipping
(2) Valve clearance too small
(3) Valve stuck open
(4) Worn cylinder and piston rings
(5) Damaged cylinder head gasket
(6) Seized valve
(7) Improper valve timing
(8) Improperly adjusted starter decompressor

COMPRESSION NORMAL

Start by following the normal starting procedure

ENGINE FIRES BUT STOPS SOON →
(1) Choke excessively opened
(2) Carburettor pilot screw excessively closed
(3) Air leaking past manifold
(4) Improper ignition timing (C.D.I. unit or pulse generator faulty)

ENGINE DOES NOT FIRE

Remove spark plug

WET PLUG →
(1) Carburettor flooded
(2) Carburettor choke excessively closed
(3) Throttle valve excessively open

DRY

Start with choke applied

ENGINE LACKS POWER

Probable Cause

1. Raise wheels off ground and spin by hand

WHEEL SPINS FREELY

WHEEL DOES NOT SPIN FREELY →
(1) Brake dragging
(2) Worn out or damaged wheel bearing
(3 Wheel bearing needs lubrication
(4) Drive chain too tight
(5) Rear axle nut excessively tightened

2. Check tyre pressure with tyre gauge

PRESSURE NORMAL

PRESSURE TOO LOW →
(1) Punctured tyre
(2) Faulty tyre valve

3. Try rapid acceleration from low to second

ENGINE SPEED LOWERED WHEN CLUTCH IS RELEASED

ENGINE SPEED DOES NOT CHANGE WHEN CLUTCH IS RELEASED →
(1) Clutch slipping
(2) Worn clutch disc/plate
(3) Warped clutch disc/plate

4. Slowly accelerate engine

ENGINE SPEED INCREASED

ENGINE SPEED NOT INCREASED SUFFICIENTLY →
(1) Carburettor choke closed
(2) Clogged air cleaner
(3) Restricted fuel flow
(4) Clogged fuel tank breather tube
(5) Clogged muffler

5. Check ignition timing

CORRECT

INCORRECT →
(1) Faulty C.D.I. unit
(2) Faulty pulse generator
(3) Faulty ignition advance

6. Check valve clearance.

CORRECT

INCORRECT →
(1) Improper valve adjustment
(2) Worn out valve seat

7. Test cylinder compression using a compression gauge

NORMAL

TOO LOW →
(1) Valve stuck open
(2) Worn out cylinder and piston rings
(3) Leaking head gasket
(4) Improper valve timing

8. Check carburettor for clogging

NOT CLOGGED

CLOGGED →
(1) Carburettor not serviced frequently enough

9. Remove spark plug

NOT FOULED OR DISCOLOURED

FOULED OR DISCOLOURED →
(1) Plug not serviced frequently enough
(2) Use of plug with improper heat range

10. Remove oil level gauge and check oil level

CORRECT

OIL LEVEL INCORRECT →
(1) Oil level too high
(2) Oil level too low
(3) Contaminated oil

		Probable Cause
1. Remove cylinder head cover and inspect lubrication VALVE TRAIN LUBRICATED PROPERLY	VALVE TRAIN NOT LUBRICATED PROPERLY →	(1) Clogged oil passage (2) Clogged oil control orifice
2. Check if engine overheats NOT OVERHEATED	OVERHEATED →	(1) Excessive carbon build-up in combustion chamber (2) Use of improper quality of fuel (3) Clutch slipping (4) Fuel air mixture too lean
3. Accelerate or run at high speed	ENGINE KNOCKS →	(1) Worn out piston and cylinder (2) Fuel air mixture too lean (3) Use of improper grade of fuel (4) Excessive carbon build-up in combustion chamber (5) Ignition timing too advanced (Faulty C.D.I. unit or pulse generator)

POOR PERFORMANCE AT LOW AND IDLE SPEEDS

		Probable Cause
1. Check ignition timing and valve clearance CORRECT	INCORRECT →	(1) Improper valve clearance (2) Improper ignition timing (Faulty C.D.I. unit or pulse generator)
2. Check carburettor pilot screw adjustment CORRECT	INCORRECT →	(1) Fuel-air mixture too lean (2) Fuel-air mixture too rich
3. Check if air is leaking past manifold NOT LEAKING	LEAKING →	(1) Deteriorated insulator O-Ring (2) Loose carburettor
4. Try spark test	WEAK OR INTERMITTENT SPARK →	(1) Faulty, carbon filled or wet fouled spark plug (2) Faulty C.D.I. unit (3) A.C. generator Faulty (4) Faulty ignition coil (5) Faulty pulse generator

POOR PERFORMANCE AT HIGH SPEEDS

		Probable Cause
1. Check ignition timing and valve clearance	INCORRECT →	(1) Improper valve clearance (2) Faulty C.D.I. Unit (3) Faulty pulse generator
CORRECT ↓		
2. Disconnect fuel tube at carburettor	FUEL FLOW RESTRICTED →	(1) Lack of fuel in tank (2) Clogged fuel line (3) Clogged fuel tank breather tube (4) Clogged fuel valve
FUEL FLOWS FREELY ↓		
3. Remove carburettor and check for clogged jet	CLOGGED →	(1) Clean
NOT CLOGGED ↓		
4. Check valve timing	INCORRECT →	(1) Incorrect installation of cam sprocket
CORRECT ↓		
5. Check valve spring tension	WEAK →	(1) Faulty spring

POOR HANDLING → Check tyre pressure

	Probable Cause
1. If steering is heavy →	(1) Steering head adjuster too tight (2) Damaged steering cones or steel balls (3) Low front tyre pressure
2. If either wheel is wobbling →	(1) Excessive wheel bearing play (2) Distorted rim (3) Improperly installed wheel hub (4) Swing arm pivot bushing excessively worn out (5) Distorted frame (6) Improper drive chain tension or adjustment
3. If the motorcycle pulls to one side →	(1) Misaligned shock absorber (2) Front and rear wheels not aligned (3) Bent front fork (4) Bent swing arm

Conclusions

Tables

Tables

Table 1. Comparison Chart of Regular (octane 83) to Premium (Octane 93)

Sr. No.	*Characteristics*	*Requirements* 83 Octane	93 Octane
(i)	Colour, visual	Orange	Red
(ii)	Copper-strip corrosion for 3 hours at 50°C	Not worse than No. 1	
(iii)	Density at 15°C	Not limited but to be reported	
(iv)	Distillation:		
	(a) Initial boiling point	Not limited but to be reported	
	(b) Recovery upto 70°C, % by volume, min	10	10
	(c) Recovery upto 125°C, % by volume, min	50	50
	(d) Recovery upto 180°C, % by volume, min	90	90
	(e) Final boiling point, max	215°C	215°C
	(f) Residue, % by volume, max	2	2
(v)	Octane number (research method), min	83	93
(vi)	Oxidation, stability, in minutes, min	360	360
(vii)	Residue on evaporation, mg/100 ml, max	4.0	4.0
(viii)	Sulphur, total % by weight, max	0.25	0.20
(ix)	Lead content (as Pb), g/l, max	0.56	0.80
(x)	Reid vapour pressure at 38°C, kgf/cm², max	0.70	0.70

Table 2. Feed Stock of Methanol

Raw materials	Coal	Lignite	Agricultural Waste	Municipal Waste
Tonnes of Feed Stock Per tonne of Methanol	1.1 – 2.2	2.8	2.1	3.7

Table 3. Comparison of LPG With Petrol & Diesel

Characteristic	Propane	Butane	Petrol	Diesel
Density at 15°C (kg/l)	0.508	0.584	0.73-0.78	0.81-0.85
Vapour pressure at 37.8 °C (bar)	12.1	2.6	0.5-0.9	0.003
Boiling point (°C)	-43	-0.5	30-225	150-560
RON	111	103	96-98	--
M.O.N	97	89	85-87	--
Low heat value (Mj/kg)	46.1	45.46	44.03	42.4
Low heat value (Mk/kg)	23.4	26.53	2.3	35.6
Stoichiometric ratio (kg/kg)	15.8	15.6	14.7	--
Calorific value Mix.S. (kj/mc)	3414	3446	3482	--

Table 5. Comparison of CNG(Methane) and Gasoline

Property Name	Methane	Gasoline
Boiling point (K)	112	310-450
Density (kg/m^3)	0.714 (gas) 422 (liquid)	730 (liquid)
Molecular weight (kg/kmol)	16.04	114.2*
Lower heating value (MJ/kg)	50.24	42.0
Stoichiometric A/F ratio		
Mass basis	17.3	14.7*
Volume basis	9.52	59.5*
Flammability limits		
Volume % in air	5.3-15	1.3-7.6*
Excess air ratio (Lambda)	1.79-0.63	1.28-0.22*
Stoichiometric mixture		
Calorific value (kJ/lit)	3.42	3.54
Research octane number	130	80-100
Laminar burning velocity at 6 bar and 500 K (cm/s)	52	58-62**
Minimum ignition energy required (mJ)	0.29	0.24*
Auto ignition temperature	1100	796*

* Properties of Iso-octane

** Properties of Indolene

Reports

Reports

1. Performance of the Vehicle with Regular Gasoline (Petrol)

   Mileage was 81 Kms/litre*

2. Performance of the Vehicle with Un – Leaded Petrol

   Mileage was 80.2 Kms/litre*

3. Performance of the vehicle with Premium Gasoline

   Premium Gasoline is not available in our country at present and will be coming shortly.

4. Performance of the vehicle with Ethanol – gasoline mixtures

% of Ethanol	0	25	50	75	100
Mileage Kms/litre*	81	72	64	57	50

5. Performance of the vehicle with Methanol – Gasoline Mixtures

% of Methanol	0	25	50	75	100
Mileage Kms/litre*	81	70	63	50	40

* Indicates Testing of Vehichle under Ideal Conditions as specified by the company and by a standard driver.

6. Performance of the vehicle with LPG

   Mileage was 302km/kg – on road test

7. Performance of the vehicle with Bio gas was found to be satisfactory and can be used SI ICE for generating power or running pumps.

8. Performance of the vehicle with CNG could not be carried out because of the non availability of CNG here. It can be used with the same kit as for LPG.

Figures

Figures

Figure 1. Fractionating Column.

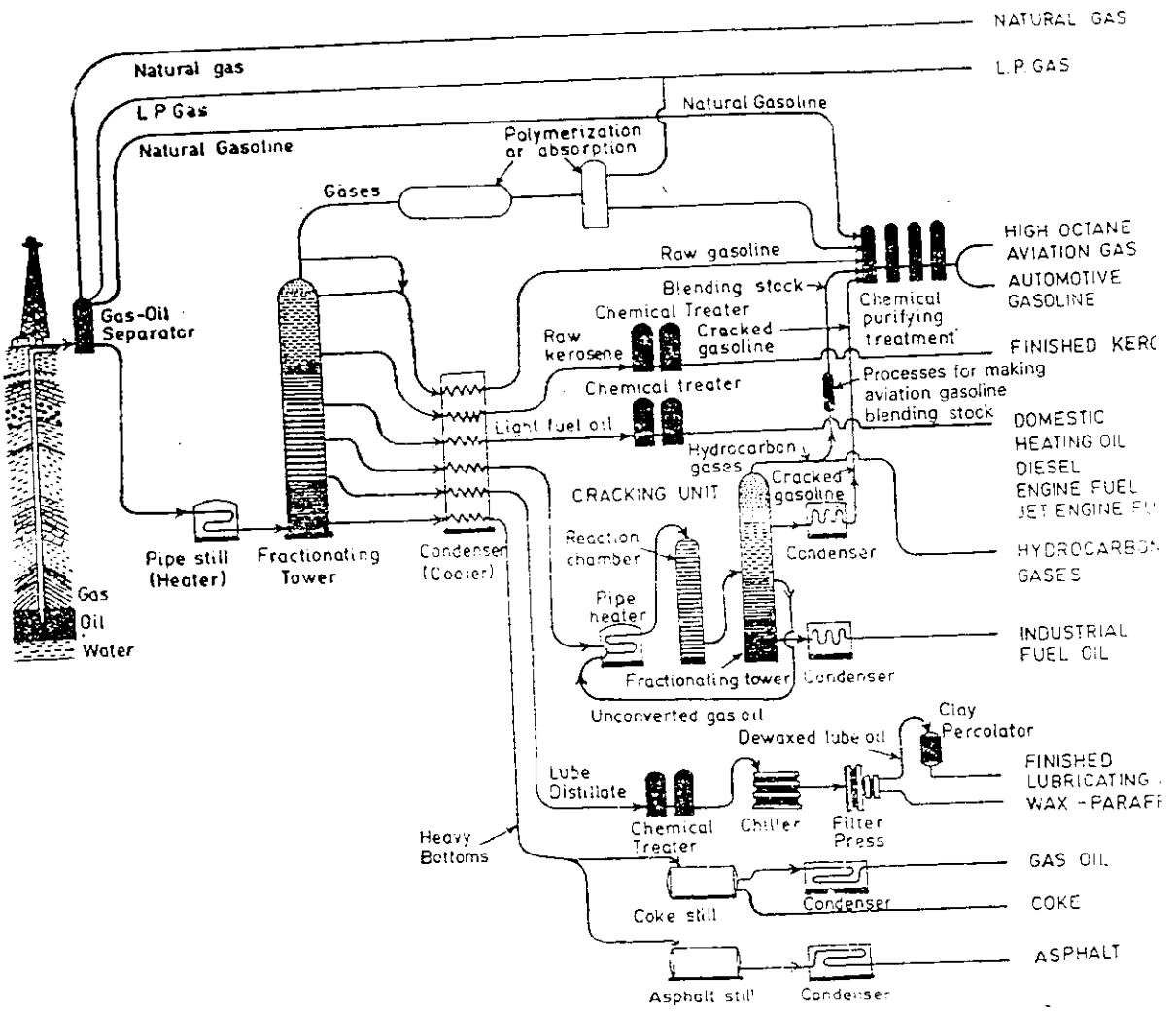
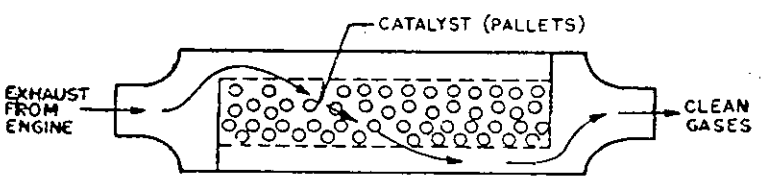


Figure 2. Catalytic Converter



Appendix

Appendix

Appendix A.

Process of Fractional Distillation:

Distillation is a process of separation on a molecular basis or on the basis of the boiling point of various fractions. The crude oil is first heated to a temperature of about 300 to 350 degree celsius in a tube heater which evaporates most of the crude oil. These vapours are then condensed in a tall cylindrical tower, approximately 1.5 to 2m in dia and 25 to 30 m in height. This tower is called the fractionating column (figure 1).

The oil pressure in the heater is kept around 3 kg/square cm. This pressure reduces undue volatilisation. The hot crude oil enters the fractionating column as a mist or spray at its lower end. The column is kept at nearly atmospheric pressure. Most of the crude oil, therefore gets vapourised and rises up. During its ascent it cools down. A number of bubble caps are fitted inside the column. The heavier fractions which have the highest boiling points gets liquefied first while the remaining fractions rise and condense in order of thei boiling points. Various fractions are taken out at an approximate temperature difference of 50 degree celsius. The uncondensed gases leave the tower from the top, and are sent for absorption.

The various fractions taken out are shown below, the table gives the yield and the boiling range in primary or straight run distillation.

The table below shows the distillate, yield and boiling range

Distillate	Boiling range, degree celsius	Yeild %
Light gasoline including gases	–	8
Heavy Gasoline	30 - 65	12
Naptha	65 - 250	5
Kerosene	150 - 250	15
Gas oil including Diesel oil, fuel oil	150 - 400	5
Residue	320 - 540	55

Appendix 2

The Catalytic Converter:

The exhaust gases from the engine are passed through Catalytic converters(figure 2.). such a converter is a cylindrical canister installed in the exhaust system between the exhause manifold and silencer and contains the plastic pallets coated with the catalyst. Three-way converters(TWC) are now commonly used in petrol and operate in two stages. The first converter stage uses rodium to reduce Nox in the exhaust into nitrogen and oxygen. In the second stage converter platinum or palladium acts as oxidation catalyst

Bibliography

Bibliography

1. Automobile Engineering Volume I & II by Dr. Kirpal Singh
   Standard Publishers and Distributors, Delhi.
2. Automobile Engineering by Dr. Narang.
3. Automobile Engineering by Dr. K. R. Govindan,
4. Internal Combustion Engine Fundamentals by John B. Heywood
   Mc. Graw Hill International Edition, Singapore.
5. Indian Auto May 1993 Issue.
6. Thermal Engineering, P. L. Balleny.
7. Thermal Engineering, C. P. Kothandaraman,
8. Development and Performance Analysis of a producer gas operated SI
   Engine, P. P. Parikh et al.
9. IIT – CNG Conversion Kit, IIT, Mumbai.
10. Utilisation of Natural Gas as a fuel for SI Engines, G. S. Khairnar.
11. LPG Systems Manual, Office Lovato S. P. A.
12. State of the World 1992, Worldwatch Insitute.
13. Complexities of Electric cars.
14. Turbo Electric Transmission, M. R. Eternad et al.
15. Environmental Benefits of Natural Gas Vehicles, Christopher Weaver.

Photographs