

INSTRUCTIONS
FOR
ITS CARE AND OPERATION

4 Cylinder
Engines

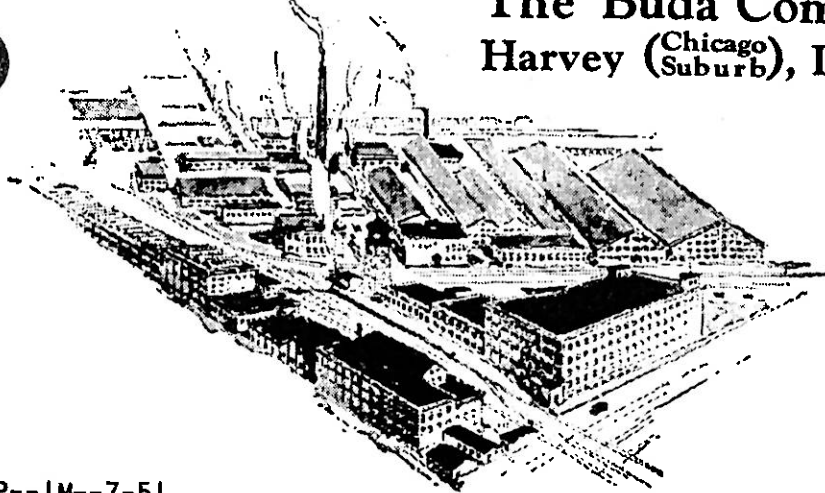
THE BUDA COMPANY
HARVEY (CHICAGO) ILLINOIS

No. 422 A

Home of BUDA, the Engine

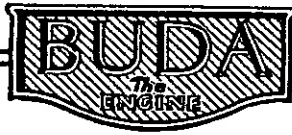
THIS company has produced gasoline engines since 1910 and in this time has built and sold in quantities one, two, four, six and eight cylinder engines all of the four-cycle type. Our manufacturing experience dates back to 1881, as we have been producers of quality products since that time. Many of the most prominent commercial vehicles and other apparatus using the internal combustion engine both in this country and abroad are equipped with Buda engines. Through our years of experience we have built and maintained a production organization of which we are proud and we take further pride in the long list of manufacturers who, by specifying our product, have testified to their confidence in our engines and our business principles. It has always been our endeavor to manufacture one grade of material—the best. We feel that the increasing use of our products throughout the world is an appreciation of **QUALITY**.

The Buda Company
Harvey (^{Chicago}_{Suburb}), Illinois



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Introduction

EVERY owner of a BUDA engine can rightfully expect years of satisfactory service. More than one hundred thousand BUDA engines have proved this all over the world. We have put into these engines the result of our years of experience in their manufacture. We have put the best of materials and workmanship into them that money can buy. We have made this skill and this craftsmanship our pride, which has no price.

You are entitled to all of this in your BUDA engine and we will be satisfied with nothing less. But, no matter how well an engine is made, it requires reasonable care and operation, for a few minutes of great abuse will noticeably shorten the life of even the BUDA.

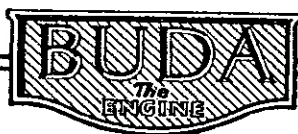
The operator must do his part. So far as is in his power, he should study carefully and put into practice these instructions, which have been written by our practical men.

This book will help the operator to avoid common mistakes where he has had little previous experience. It is intended to inform the expert as to the exact way in which the BUDA engine should be operated, maintained or repaired to secure the best results.

The expert operator or service man knows that all engines may be alike in theory and yet differ in practice. We are giving you in these pages the actual practice followed out by each department of our company in production or service repair work.

We can not hope to make an expert of every operator or service man, but we do know that a careful study of the methods and practice given in the following pages will help both of us.

This book may not give you the exact information you require, and if such is the case we will be very glad to have you write us direct about any doubtful subject. Please address the Service Department of this company at Harvey, Illinois, mentioning this book.



I. Timely Hints

THE engine should be kept clean and oil should never be allowed to collect on the wires or electrical equipment.

Keep the radiator filled with clean water and do not run the engine without water in the cooling system, or add cold water to an overheated engine. If the radiator leaks, have it repaired. Do not use radiator cements that are applied internally, as they hinder the cooling action of the radiator.

Use the carburetor choke no more than necessary, as this allows raw gasoline to enter the cylinders, pass the pistons and dilute the oil.

In starting a cold engine let it warm up slowly. Never race it.

Do not race the engine under any circumstances, or drive a new truck fast for the first 500 miles.

If the engine knocks on hard pulling, retard the spark until it operates smoothly. This will give just as much power and is easier on the engine.

Do not let the engine labor in high gear. Drop into a lower gear. The transmission is there for that purpose. It is a poor driver who strains his car in trying to make the hill "on high."

Do not run the engine if the radiator is frozen. Apply hot water to the inside and outside of the radiator and cover up until thawed.

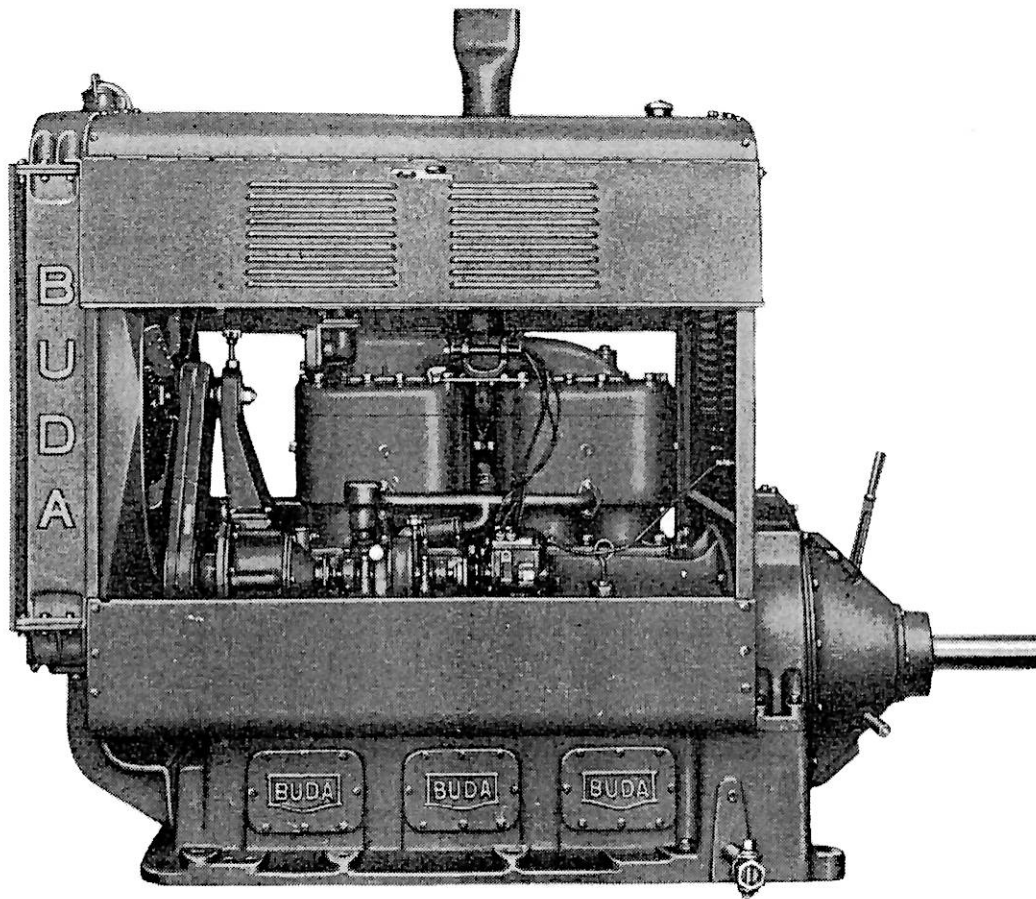
To start engine in cold weather turn engine over three compressions with choke valve in closed position and ignition switch OFF. Open choker half way, turn ignition switch ON and start engine. This will eliminate extreme flooding and if ignition is O. K. will prove a satisfactory method of starting. As soon as possible push the choker lever to the running or open position. Never run with the choker on—wait until the engine is properly warmed up.

Freezing Mixtures

Denatured Alcohol and Water

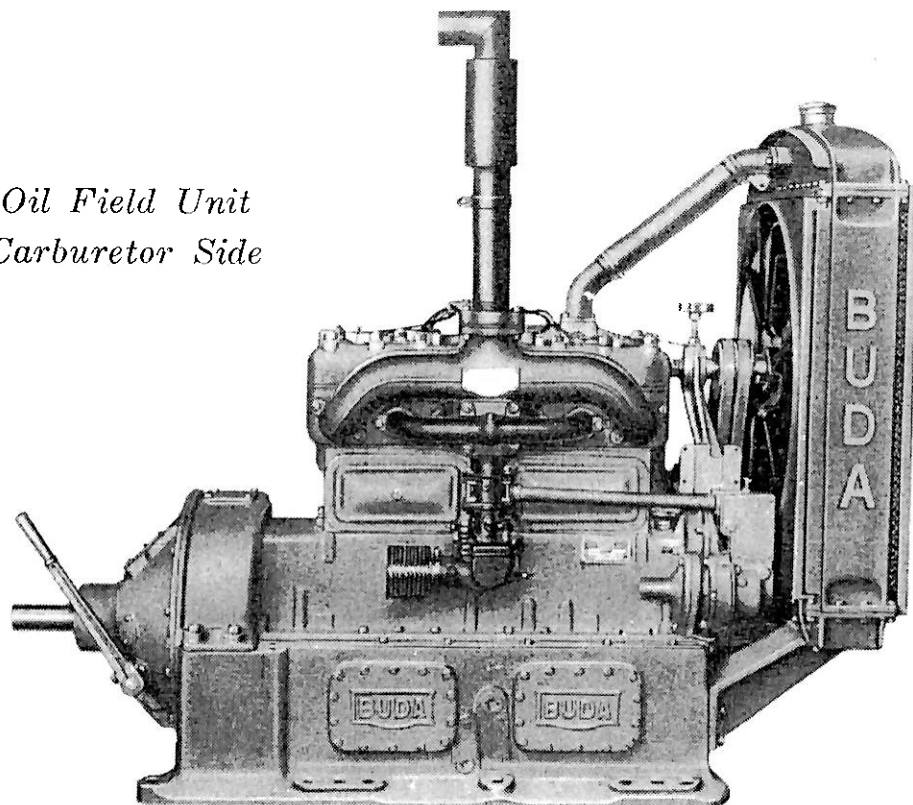
Freezing temperature degrees fahrenheit	Amount of alcohol to add to each gallon of water
20	2 pts.
0	4 pts.
-20	6 pts.
-40	10 pts.
-60	19 pts.

For example, for each gallon of water placed in the radiator when the temperature draws near 20 below zero, add six pints of denatured alcohol.



Oil Field Unit—Water Pump Side.

*Oil Field Unit
Carburetor Side*





II. Care of the Engine

A GENERAL inspection of the engine should be made at regular intervals, to insure long life and to prevent breakdowns while on the road. One hour a week spent on this inspection will save time and money in the end.

What to Do Each Day

1. Check the oil level on the bayonet gauge and add more to the supply if necessary.
2. Turn down water pump grease cups.
3. Fill radiator.
4. Make sure ignition wires and terminals are tight.

What to Do Every 500 Miles or Every Week

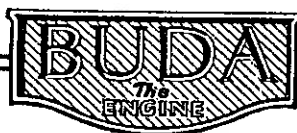
1. Drain oil and replace with fresh to the proper level.
2. If magneto, starter and generator are used, give bearings a few drops of oil (3 in 1).
3. Give fan bearing a few drops of light oil.
4. Tighten water pump packing nuts until snug.
5. Tighten fan belt if loose.
6. Clean carburetor gasoline strainer each week for the first month.
7. Tighten all loose nuts, bolts and cap screws.

What to Do Every 1000 Miles

1. Check valve tappet clearance and re-set when necessary.

What to Do Every 1000 Miles

1. Remove cylinder head, clean carbon and grind valves, then re-set tappet clearance.
2. Drain oil and flush out oil pan. Do not use kerosene for rinsing; use one gallon of cheap light oil, or regular flushing fluids which can be purchased at oil stations. Drain this rinsing oil, and refill crank case with fresh oil to the proper level. Do not rinse with kerosene.
3. Remove plate at bottom of oil pan; remove oil screen and clean it.



4. Clean carburetor gasoline strainer.
5. Drop and clean oil pan and inspect bearings.

What to Do Each Year

1. Give the engine a complete general overhauling.

III. General Engine Information

Operation of Four-Cycle Engines

WITHIN each cylinder of the engine is a piston which has an upward and downward movement.

This movement is controlled by a crankshaft to which each of the four pistons is attached by means of a connecting rod and piston pin.

The full movement of a piston in either direction is called a stroke. There are two strokes of the piston to each full revolution of the crankshaft.

By "one cycle of the engine" is meant the complete cycle or circle of operations which takes place in the engine from the time the charge of gas is first drawn into the cylinder until it is again time for a new charge to be drawn in.

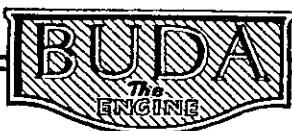
In the four-stroke cycle engine four strokes are required for one complete cycle of operation, i. e., one down stroke, one up stroke; one down stroke, one up stroke.

It will be seen that in any engine two strokes of the piston (one down stroke and one up stroke) are required for one revolution of the shaft.

These four strokes are named in the order in which they always appear, namely: (a) Suction Stroke, (b) Compression Stroke, (c) Firing or Power Stroke, and (d) Exhaust Stroke.

There are two valves to each cylinder, the intake valve and the exhaust valve, for the purpose of opening and closing passages between the intake and exhaust manifolds and cylinders.

The valves are made to open by the action of cams upon a camshaft located within the crank case, and driven at half crankshaft speed, through gears driven by the crankshaft. They are closed by springs.



If the crankshaft of the engine is revolved until the first explosion occurs, the following action takes place within the cylinder:

Upon the Suction Stroke (a) of the piston the intake valve is mechanically opened, and as the piston moves downward gas is drawn from the carburetor (by the partial vacuum created) into the increasing space between the top of the piston and the head of the cylinder. (The exhaust valve is closed at this time.)

At the end of this stroke the piston starts upward ((b) Compression Stroke), both valves are made to close and the gas is compressed into a small space, making it highly explosive.

When the end of the stroke is reached, and just as the piston starts downward again, the compressed charge is ignited by means of an electric spark which takes place between the points of a spark plug screwed into the top of the cylinder head.

The ignition of the gas causes an expansion or explosion which drives the piston rapidly downward ((c) Firing or Power Stroke), at the same time imparting movement to the other three pistons which are attached to the main crankshaft.

Both valves remain closed during this stroke.

In the next stroke, which is upward ((d) Exhaust Stroke), the exhaust valve is opened to allow the burnt gas to be forced out by the piston through exhaust manifold and muffler into the open air. The intake valve remains closed during this stroke.

These strokes follow each other in the manner described as long as the engine is in operation and exactly the same series of actions occur in all four cylinders, although no like strokes are taking place at the same time in any of the cylinders: One is on its Suction Stroke, one on its Compression Stroke, another is on its Firing Stroke and the other is on its Exhaust Stroke.

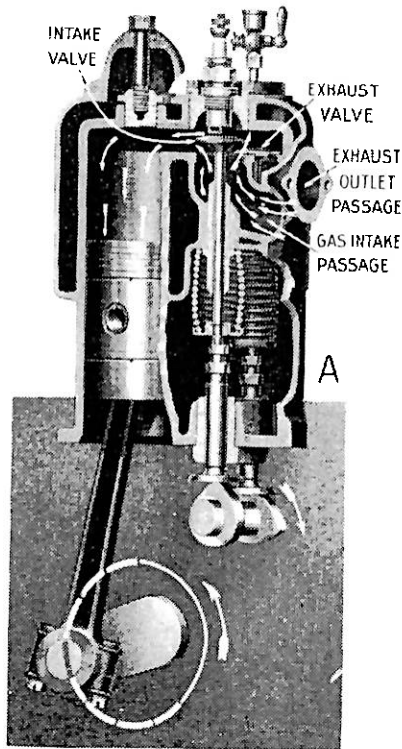
In this way the explosions are so divided that there is one power impulse to each half revolution of the crankshaft.

The explosions always occur within the cylinders in this order: No. 1, No. 3, No. 4, and No. 2.

This is termed the firing order of the engine.

No. 1 cylinder is the one nearest the radiator.

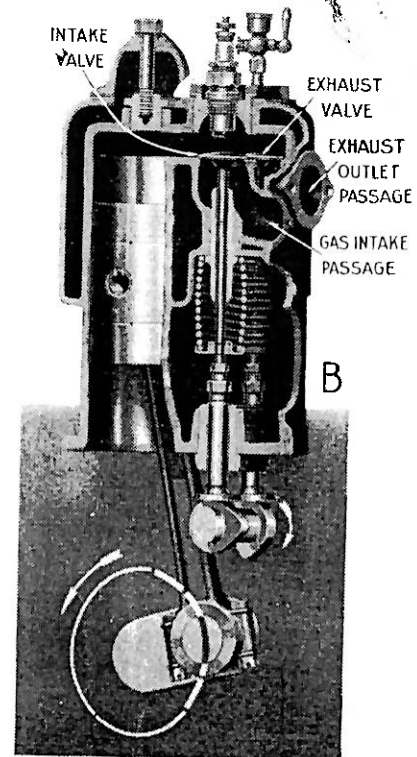
The operation of four-cycle engines built by the BUDA Company may be better understood by the accompanying illustrations:



Suction Stroke

(a) *Suction Stroke. Piston is moving from top to bottom of the cylinder. Intake valve is open, allowing mixture of gas and air to enter the cylinder. Exhaust valve closed.*

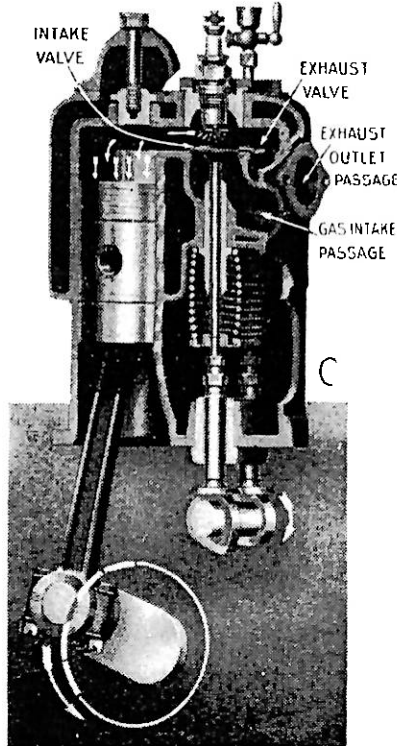
(b) *Compression Stroke, Piston moves from bottom to top of cylinder, compressing the charge to about $\frac{1}{4}$ its original volume. Both valves closed.*



Compression Stroke

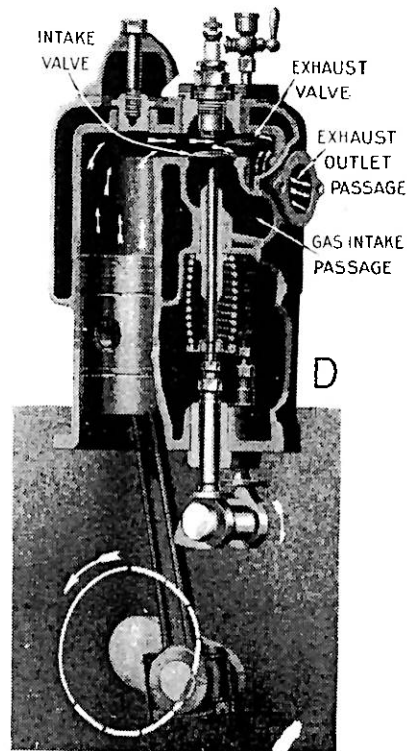
BUDA

The ENGINE



Power Stroke

(c) *Power Stroke.* Compressed charge is fired by a spark across points of spark plug, driving piston down. Piston moves from top to bottom of cylinder. Both valves closed.



Exhaust Stroke

(d) *Exhaust Stroke.* Piston moves from bottom to top. Exhaust valves open, allowing burned gas to escape. Intake valve closed.



Importance of Using Good Oil

All things wear out in the course of time, depending on the care that has been given to them. Your BUDA engine is no exception to this rule. You can take more out of the BUDA in service than you put into it in care. On the other hand, you can pay more for it in trouble than you can possibly save by being careless—carelessness not only in repairs but in operation and more particularly carelessness in oiling or lubrication.

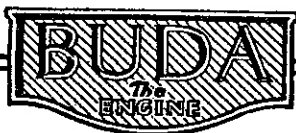
Careless operation may mean overspeeding, running with dirty oil, dirty plugs, or a poor ignition system, a bad carburetor or poor adjustment, insufficient cooling water or a slack fan belt, or any one of a hundred different things. Careless repairs may mean a poorly ground valve, badly fitted rings, or loose bearings and the like, but many times a good grade of oil will keep a poorly repaired engine running for an otherwise careless operator.

Oil, enough of it, and a good grade, is the most important thing in the operation of an engine. We cannot say too much about the need of good oil of the proper body. The oiling system of an engine is the final means by which you may judge its success or failure. That an engine will use little fuel is of course important, but no good is accomplished by an engine that is saving in fuel when it is not or cannot be oiling properly.

The matter of fuel saving is largely one of fitting a good carburetor or keeping it adjusted and operating with a hot spark, properly timed. This is to a great extent out of our control as engine builders, although we have done our part by supplying a properly designed intake pipe with good valves properly timed. Should your engine burn too much fuel, this can be quickly noticed and corrected, but it is unfortunate that the trouble caused by a poor oil is seldom noticed until it is too late to do anything.

The best oil is the cheapest in the long run, although at first a cheap oil may show a saving. Find one grade of oil that is good and use this only. Nothing is gained by changing from one brand to another and great damage to your engine may result.

We have built a good oiling system into the BUDA engine and we know that by using a good oil of proper body or viscosity, drained fre-



quently as it thins with use, your BUDA will give effective service for years. You can save money by buying a good grade of oil and make sure that one is the best.

The Importance of Keeping Your Engine Valves Tight

From the previous explanation of how the BUDA four-cycle engine operates, it is easily seen that the successful running of the engine depends on the valves being leak-proof and the length of time in which they stay that way.

Valve trouble will start very quickly from the use of *poor engine oil*. We believe that oil is the most important thing used in your engine from a dollars-and-cents standpoint. Poor fuel of course will make the cost of operation somewhat higher, but even poor fuel properly vaporized will cause no wear on the new engine. It can only cause wear through poorly fitted piston rings allowing too much oil to work into the firing chamber, which picks up poorly vaporized fuel and thus thinned, is readily washed back into the crankcase. This has the effect of diluting or cutting the oil in the crankcase and destroying its lubricating value.

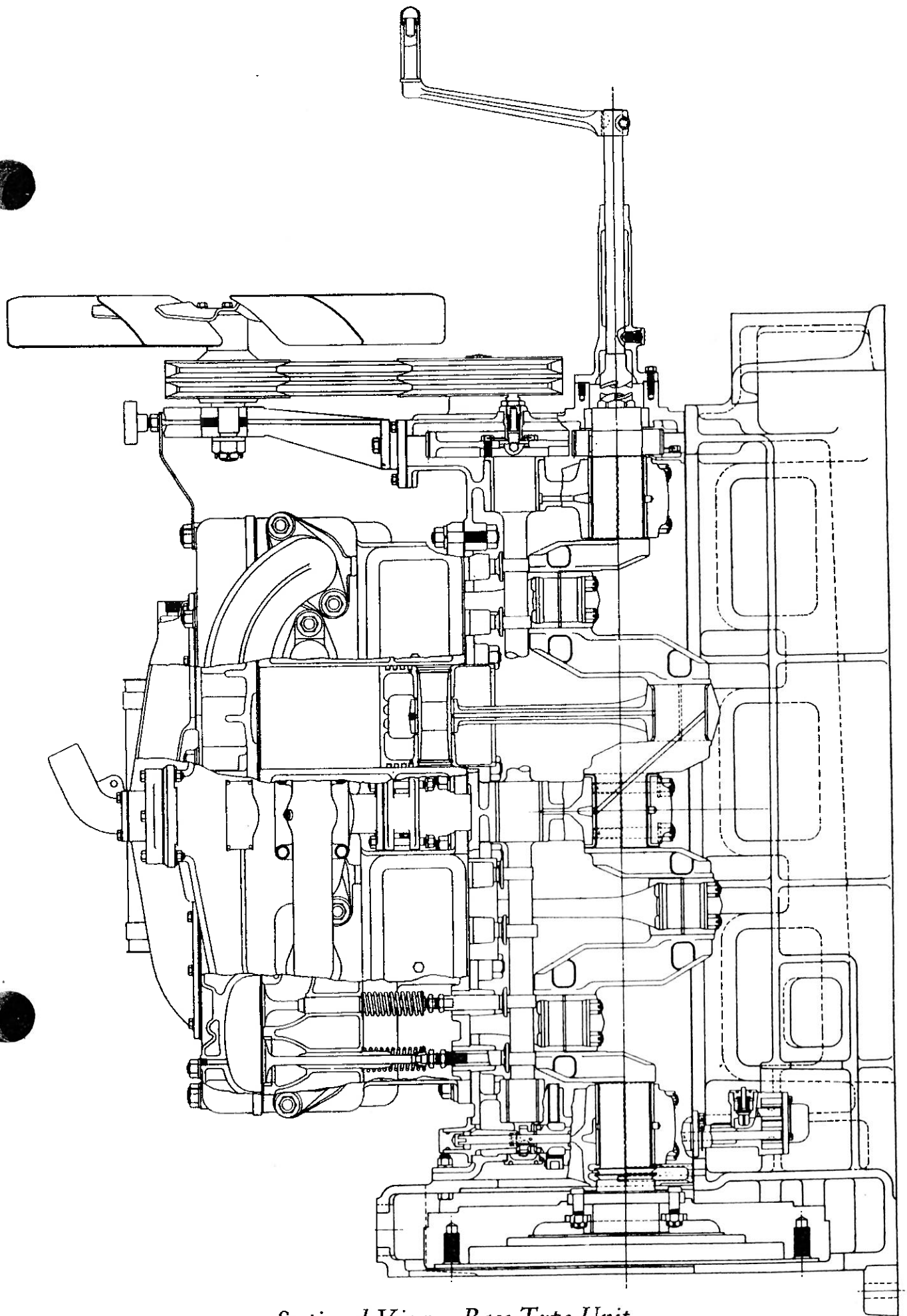
Poor oil causes a very rapid *wear of the piston rings and cylinder walls*. Worn rings will allow oil to pump up and fuel to wash down.

A good oil will prevent wear on the piston rings, keeping them tight longer, and allowing little excess oil to be burnt or pick up drops of fuel in the firing chamber.

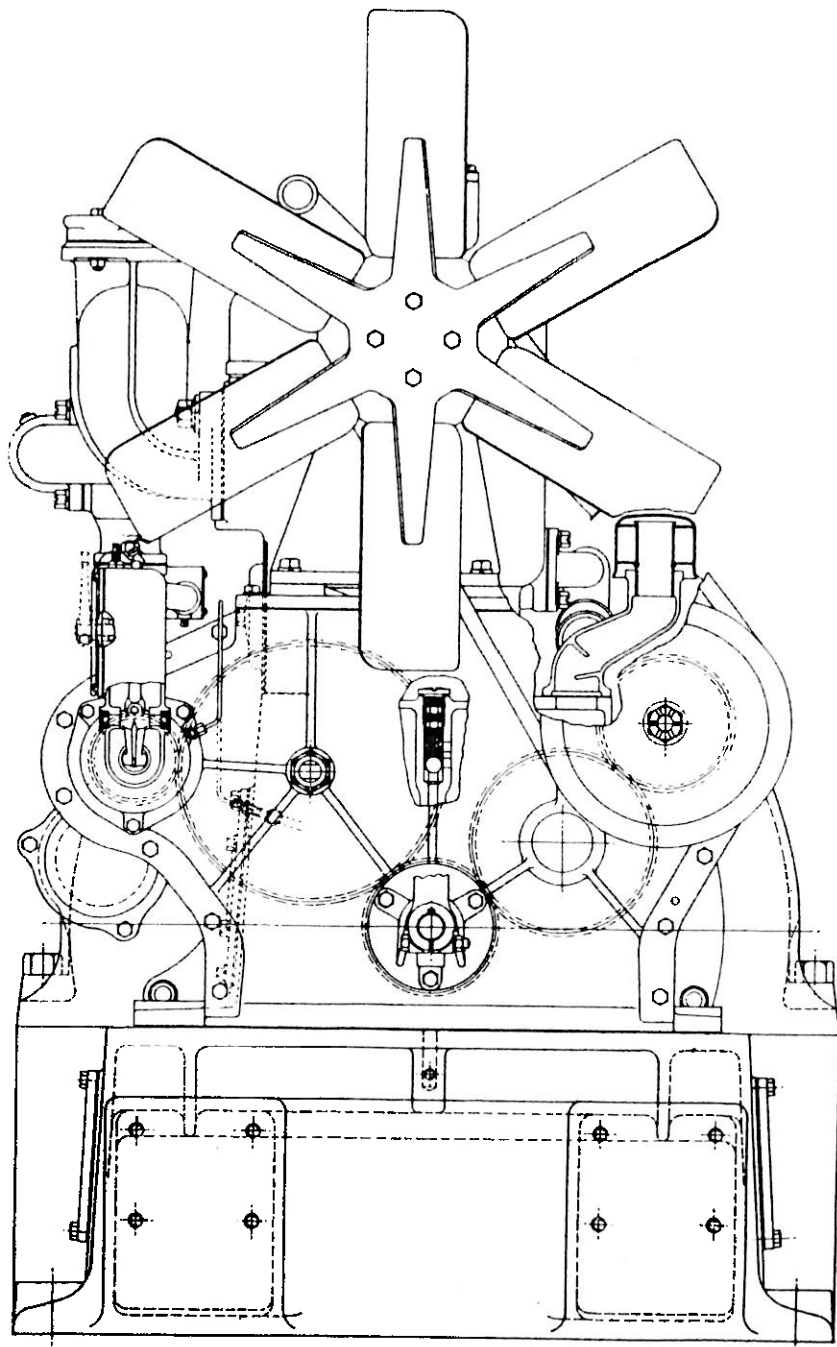
Oil pumped into the firing chamber will pick up poorly vaporized fuel and, being thinner in consequence, will burn or wash back into the crankcase.

Worn rings will pump large quantities of oil into the firing chamber, where some of it burns to a carbon crust or scale. Large deposits of this scale in the firing chamber will cause *pre-ignition or knocking* in the engine unless it is removed.

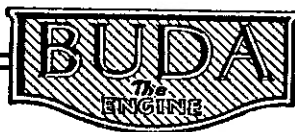
Small pieces of this carbon, however, are always working loose from vibration or the quick action of the hot gases and these must pass out of the engine by way of the exhaust valves. Should a flake of this carbon stick to any of the valve seats (and it very often does)



Sectional View—Base Type Unit.



**The Sectional Views show the four-cylinder designs.
The six-cylinder engines are similar in all respects.*



it keeps the valve from properly closing. If the flake is hard, the constant action of the valve working up and down will pound it into the metal of the seat, which is commonly called "pitting."

It is very important for the valve to fit the seat closely, not only to avoid leakage but to assist in *getting rid of the heat* in the valve head. When the engine leaves the factory, the valves are tight and there is a definite gap or clearance between the end of the valve stem and the push rod or tappet beneath which lifts to open the valve.

This Tappet Clearance or Gap Is Very Important and Must Be Maintained

While the engine is new, this clearance should be examined quite frequently as the valve seats in a new engine tend to lower somewhat due to the constant seating of the valve in the cylinder block. This action has the effect of hammering the metal to a closer grain in the valve seat, making a more perfect fit, and insuring against any power loss from leakage.

In fact, the iron in the valve seat is actually changed in character by the constant peening action of the valve head, becoming harder with use until it finally assumes a burnished or glazed appearance. If this finish is maintained, it will insure a long operation of the valve without regrinding.

It is well to bear this in mind in regrinding a valve *and avoid the use of a reamer or valve seating tool as much as possible*. These tools, of which there are too many on the market, have a tendency, in unskilled hands, of removing too much of the hardened metal of the valve seat, which will cause the reground valve to sink more than it should.

Preventing Gas Leakage Is Not the Only Reason for Tight Valves

Should the tappet clearance or gap close up, due to seating in of the valve, and no attention given to keeping it at the proper distance, trouble is sure to occur sooner or later.

This is due to the reason that the valve head, while a part of the



firing or combustion chamber of the engine, differs greatly from the other sections of these walls.

Every portion of the firing chamber has a means of cooling. When it has not, that section will quickly become red hot. There is water around the cylinder heads and barrel, and the head of the piston loses its heat from running in the cooler barrel and through contact with the oil splashed up inside by the connecting rod or crankshaft.

The valves and, more especially, the exhaust valve must get rid of their heat in a different manner. The intake valve is generally kept cool by the incoming stream of cold gas and for that reason usually gives very little trouble.

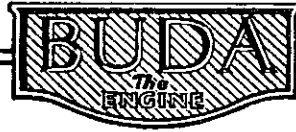
The exhaust valve, however, has not only its *head exposed to the heat* of the firing chamber, but *its stem as well*, during the time the valve is open and the hot gas is rushing out. Very little of the heat can pass out of the valve head by way of the stem as it is quite small.

The valve head actually loses most of its heat through touching the cooler valve seat. It is easily seen that the longer the valve head is in contact with the seat, the more rapidly will it lose its heat. The timing or valve lift of the BUDA engine is so arranged that the valve will have the longest possible contact with the cooler cylinder seat and yet open quickly enough to allow the engine to work properly. This was one of the reasons for our adopting the so-called *mushroom* type of cam and push rod, which is to some extent responsible for the unusual performance of our engines. The nearer the tappet clearance is held to our recommendations, the longer will the valve head be in contact with the cold seat and the cooler will it run in consequence.

The exhaust valve is in contact with the seat over two-thirds of the time the engine runs while the intake valve is in contact for seven-tenths of the time. It is easy to understand, therefore, the two important reasons for keeping the valve seats perfect.

A table of our advised tappet clearances follows and it will be noticed that less clearance is called for on the intake valve tappets as these valves run cooler than the exhaust.

If these clearances or gaps are not maintained, the valve will remain open longer and run hotter; and with the high heat, carbon deposits or metallic scales will form, especially where the valve head does not fit the seat tightly. This makes the condition still worse as



the scales do not permit the heat to pass from the valve head to the seat and being very hard they will gradually cut the valve seat away.

In a very short time the valve head will be running red hot, being unable to get rid of its heat except possibly in a very small spot. Operation in this condition without regrinding will soon result in a badly burned valve and a consequent loss of compression and power. For this reason, on a new engine, inspection of the tappet clearance should be as frequent as the circumstances will permit until the engine is well run in.

Valve grinding is one of the most important repairs on an engine. If it is not done properly, there is soon the need of a more serious repair such as putting in a new valve or even the replacement of the cylinder block itself. Too much time can hardly be spent on this particular job and where this work is being done for you by others you should see that it is done right. Too many repairmen feel competent to do this work who should never be allowed to touch a valve.

Important Features Covering Design of BUDA Engines

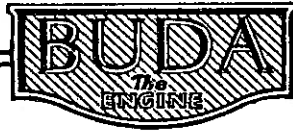
The BUDA name plate on the engine beneath the hood of your truck is a guarantee of satisfactory engine performance. From the standpoint of Durability, Economy, Power and Accessibility, "BUDA the Engine" is unequaled.

Durability.

Is one of the foremost items in connection with any product. BUDA engines are designed with extremely large bearings; crankshaft and camshaft bearings are lubricated by a special patented oiling system. Having extremely large bearing, the life of the bearings assembled in the engine is extended indefinitely, providing the engine is properly serviced. All valves are of one-piece alloy steel. Valve seats in cylinder are surrounded with sufficient amount of water to insure proper cooling. These two factors assure a long-lived valve.

Economy.

Engines are fitted with a special hot spot manifold designed for low grade fuel. Temperatures of the inlet gases are such that fuel is



completely broken up, thus assuring a minimum amount of crankcase dilution. Considerable thought has been given to the operating speed of engine and the camshaft is designed so that the best economy factor is received at recommended governed running speed of engine. The economy factor in truck operation is becoming a very essential factor in the purchasing of truck engines, as is very evident from fleet owners' carefully kept records.

Power.

In the design of BUDA engines we have considered power one of the foremost items. The camshaft has been carefully designed and the power is furnished at the speed desired by the truck driver. Piston rings are of special grey iron material, each one being machined from a separate casting. Inasmuch as the piston rings and valves are extremely important items in the power of an engine, we take great care in specifying the highest grade material and workmanship in these parts.

Accessibility.

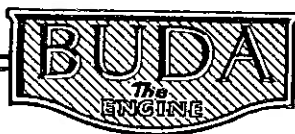
In the design of BUDA engines the accessibility of all parts is made an important factor. Pistons may be removed from the cylinder past the crankshaft; main bearing caps and valve assemblies may be removed easily. We know that considerable time can be lost in tearing down and building up an engine if accessibility is not incorporated in its design.

Cooling System.

The cooling system now used in BUDA engines is the result of years of study. The water is forced by the water pump through a passage between Nos. 2 and 3 cylinders directly up into the valve gallery. This allows the cooler water to circulate around the valve seats first where it is most needed. The water then passes around the cylinders and up through the cored passages into the cylinder head and out to the radiator.

Oiling System.

The oiling system is of the forced feed type. The main, connecting rod and camshaft bearings receive their oil under pressure from the

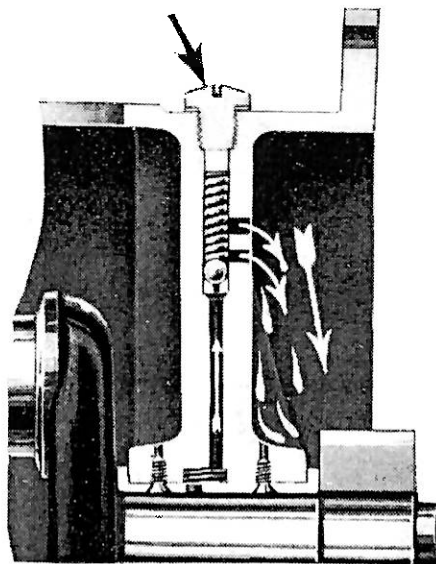


gear pump driven from the camshaft. Refer to No. 47 in sectional view on page 13.

The oil is drawn through the screen of the pump, which projects down into the oil pan. The oil then passes around the gears in the pump and is forced by them up through the main oil line, which runs lengthwise of the engine. This oil line is of seamless tubing with welded-on branches and is cast into the crankcase. There are branches from this line to the camshaft bushings and to the main bearings. The oil under pressure passes up through a hole in the center of each main bearing. These holes feed the oil to the oil grooves, then the main bearings. The crankshafts are drilled from the main bearing journals to the connecting rod journals. As the crankshaft rotates, one opening of these holes travels over or in line with the oil grooves in the main bearings. Consequently, oil under pressure is continuously forced to all connecting rods as well as main bearings. Since these main bearing oil grooves are responsible for the supply of oil to the connecting rods, precaution is taken to see that these grooves are of sufficient depth and width and at the same time that the holes in the crankshaft line up with the oil grooves in the main bearings.

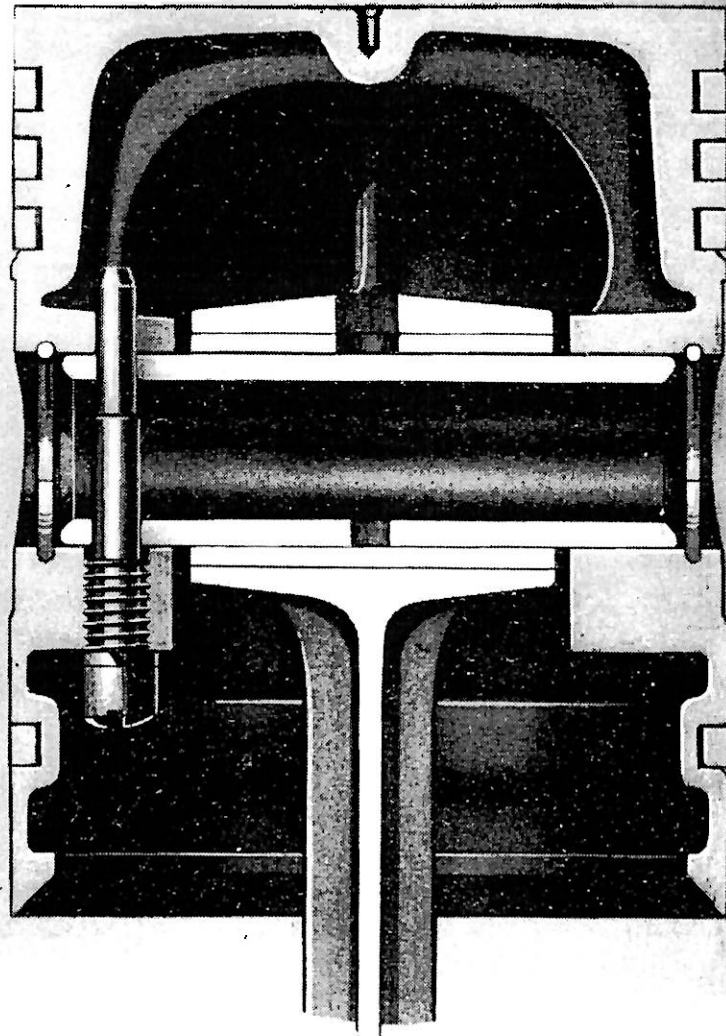
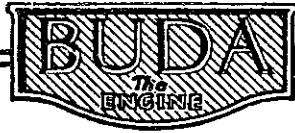
This oil, being under pressure, is forced out of the ends of the rod bearings as the crankshaft revolves and is thrown up into the cylinders and pistons. There are slots in the upper ends of the connecting rods which catch some of this oil and feed it by gravity to the piston pin bushings in the connecting rods.

The revolving parts of the engine whip the oil into a fine spray or mist which works its way, together with some solid oil, up into the valve enclosures through holes in the cylinder foot provided for this purpose and lubricates the push rods and valve stems. This oil mist works into every



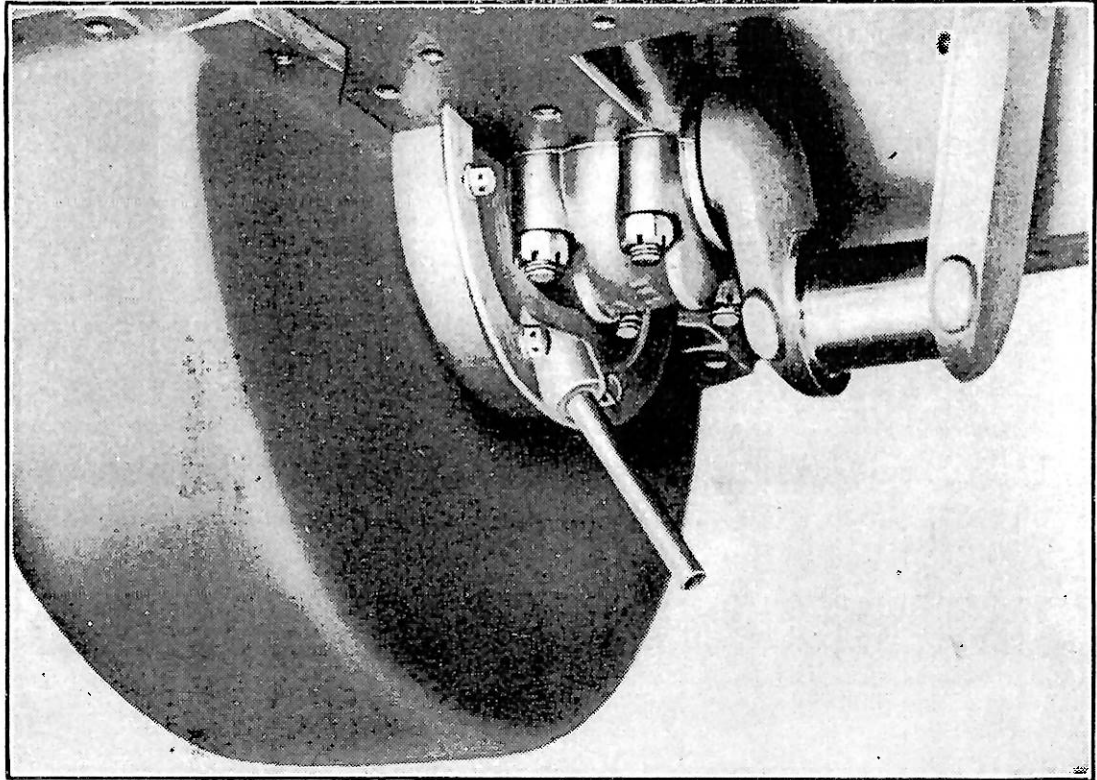
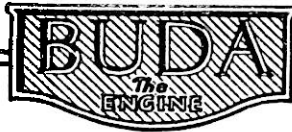
Section of Oil Relief Valve

Oil pressure is regulated by this check valve. Regulation is simply made by the addition or removal of washers to increase or decrease the pressure of the spring which holds the ball on its seat.



Section of Piston and Pin Assembly

Spring retainer ring which expands in grooves in end of piston bosses.

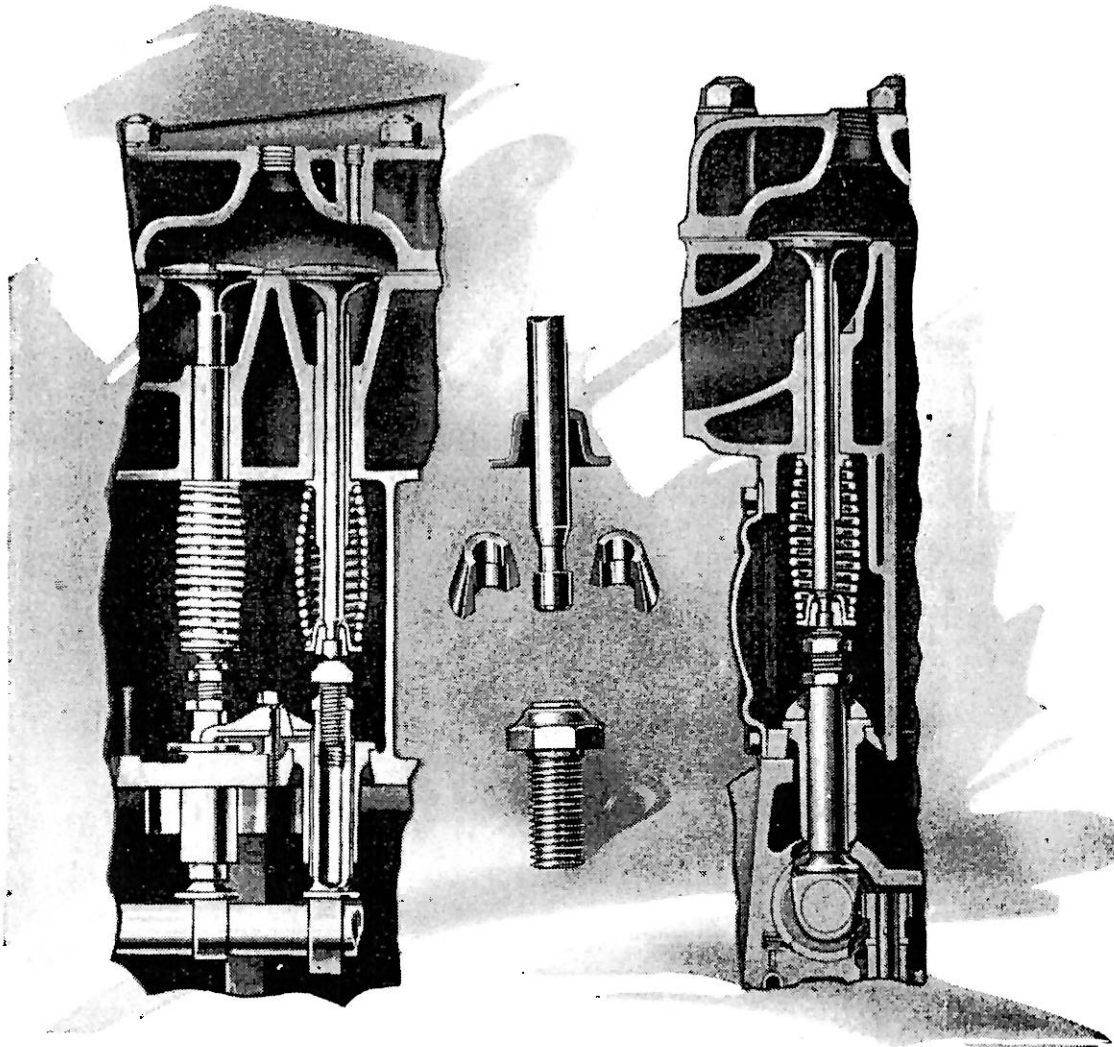
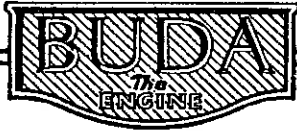


Oil Retainer in Place Against Cap

part of the crankcase and reaches every bushing, together with solid oil. The water pump and fan drive shaft bushings are lubricated by oil thrown from the gears, the oil being caught in pockets and fed to the bushings by gravity. The idler gear stud is hollow and the idler gear bushing is lubricated by oil collected in a pocket on the inside of the crankcase.

The capacity of the oil pump is greater than the amount of oil which will be forced out around the bearings. In order to keep a constant pressure and not allow it to build up, there is a by-pass valve in the front of the engine. It is composed of a ball and spring as shown in illustration on page 17.

When the pressure rises above a certain desired amount, the ball is lifted from its seat and the oil flows out through the by-pass hole and onto the gears. There is a second by-pass hole above the first. At high speeds the ball is lifted high enough to allow the oil to pass

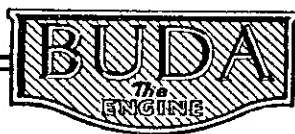


Section of Cylinder Showing Valve Stem, Spring and Retainers

out through both of them. At idling speeds, there is enough oil passing the ball valve to lubricate the gears.

Piston Pin Lock.

The piston pin is a driving fit in the piston and is held in place by a two diameter screw which passes up through the pin and one pin boss. As a double precaution, there is a spring wire lock ring inserted in a groove in each piston boss at each end of the piston pin. This is positive assurance against cylinder scoring by the piston pin.



Rear Main Bearing Oil Retainer.

All BUDA engines are equipped with oil retainers at the rear main bearings. This retainer is a shield that fits up against the bearing cap, thus preventing the crankcase pulsations from blowing oil out around the crankshaft. Any oil which may leak through the main bearing and behind the retainer is led back into the bottom of the oil pan by a tube. With the use of this retainer, there is no oil leakage past the crankshaft into the flywheel housing. See cut, page 19.

Valve Springs and Retainers.

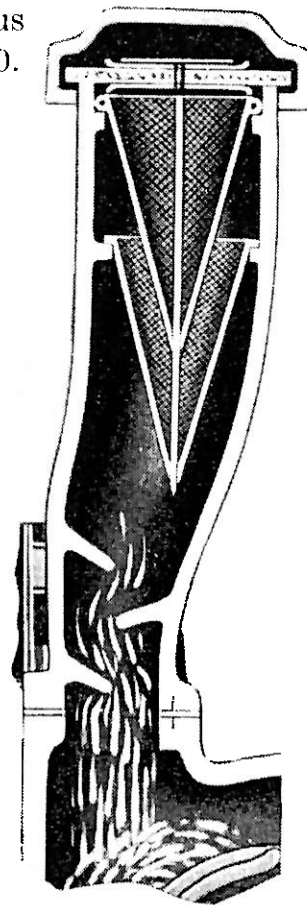
The valve springs on BUDA engines are the barrel type, which insures self-alignment on the retainers, and reduces valve stem and guide wear to a minimum. The split cone retainer locks allow no motion between the valve stems and locks, thus eliminating wear at this point. See cut, page 20.

Breather and Oil Filler.

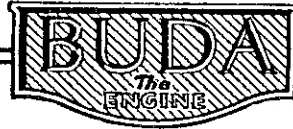
All BUDA engines are provided with an extra large combined breather and oil filler, equipped with two strainer screens and also provided with a disc valve at the top which permits the engine to exhale only. This arrangement prevents any dust or other foreign matter from entering the crankcase.

Carburetion.

As there are numerous makes of carburetors in use, no specific instructions can be given for adjustments that would cover them all. If the carburetor is working satisfactorily, *leave it alone*. If in doubt, let the service station see it operate and make any adjustments necessary. One thing should be especially remembered: A carburetor cannot be set for economy and for power at the same



**Section of Breather
and Oil Filler**



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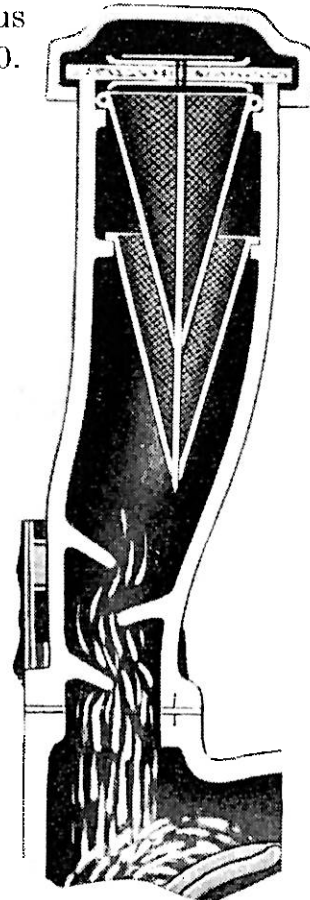
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Breather and Oil Filler.

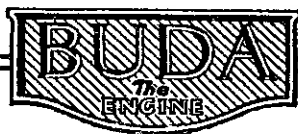
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**Section of Breather
and Oil Filler**



time. If the car has no heavy hauling, where the engine is not required to deliver its full power, the carburetor may be adjusted leaner than for heavy work.

Ignition.

The proper setting of the ignition, whether magneto or distributor, is to fire, with the instrument *fully retarded*, when the pistons are on the top dead center of the firing stroke.

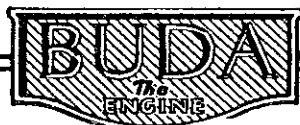
In unfamiliar with the particular electrical system on the engine, it is best to let the service station check the setting and make any necessary adjustments of the points, as different systems require different gaps between the points.

In every case where the closed circuit system is used, which is the most universal, the firing takes place at the moment the points start to open, when the instrument is revolved in the natural direction of its rotation. As the contact points are touching during part of the revolution of the breaker, it is necessary, in the case of these distributors which take battery current, to keep the switch turned off at all times while the engine is not in operation or the battery will be run down.

Setting Ignition.

To set the ignition, turn the engine until No. 1 cylinder is under compression, which can be detected by opening the priming cock of that cylinder, then turn the engine slowly until the D. C. mark of No. 1 cylinder is directly up, as viewed on the flywheel through the inspection hole on top of the flywheel housing. This is the position when firing should take place when the ignition apparatus is fully retarded. Loosen the magneto coupling, or in case of the distributor loosen the cam, and turn until the secondary brush is in a position to allow the spark to pass into No. 1 wire. With the spark lever fully retarded, turn slowly in direction of rotation until the contact points just start to open. This is the correct firing position and the coupling should be connected up or the cam tightened down, according to the apparatus employed.

Magnetoes having impulse starters should be set as mentioned above, but this precaution must be taken: See that the impulse



starter is tripped before locking the coupling. The usual method is to turn the magneto until the impulse starter trips, then backing it up and turn forward to the proper location.

Generator.

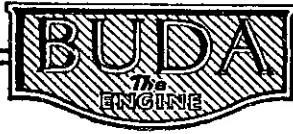
Numerous makes of generators are used on BUDA engines, but their general construction and operation is much the same. The charging rate; as indicated by the ammeter on the instrument board, should not be higher than recommended by your battery service station, or the battery will become overheated on long runs. The generator will naturally run warmer than the engine, due to the internal electrical resistance, but this does no harm, provided the charging rate is not too high.

Starter.

The starting motor will require little attention outside of a little oil, as mentioned in the first part of this booklet. In using the starter switch, press it down tight so as to make a good contact. A slight pressure will make a poor contact, which will allow the starter to turn slowly causing the starting pinion to chew into the end of a tooth of the flywheel gear and stick. If this happens, the engine can be freed with the crank, but the flywheel tooth should be dressed up with a file at the first opportunity, by removing the starting motor. Make sure that the starting pinion is not gummed with oil from the transmission and that it has backlash when in mesh with the flywheel gear.

Governor.

The governor is a safety device to check the engine and not allow it to turn faster than a safe speed, and to allow the car to move along the road at the maximum speed for which it was designed. Many drivers open up their governors, that is, set them at a higher speed than that recommended by the manufacturers of the vehicle. Most governors are sealed by the manufacturer or the service station and the guarantee is void if the governor is reset by the customer. If more speed is required of the car, the customer should consult the service station and have them make the resetting, if they think it advisable. It may be necessary to change the gear ratio instead.



Most governors run in oil, and the oil reservoir should be kept full at all times. Consult the instruction book for the particular governor employed or refer to the service station.

Battery.

The battery must be kept filled with distilled water to the proper level as indicated in the instructions which come with the battery, or can be obtained from a battery service station. Keep the terminal wires tight. Remove and clean the positive wire when it becomes green and coat with vaseline or cup grease.

Water Pump.

The water pump grease cups should never be screwed down too tight, or in case pressure grease systems are employed care must be taken that too much grease is not forced into the bushings. Excess grease will work into the water pump and will be carried up into the cooling system, lining the walls of the cylinders and radiator with grease.

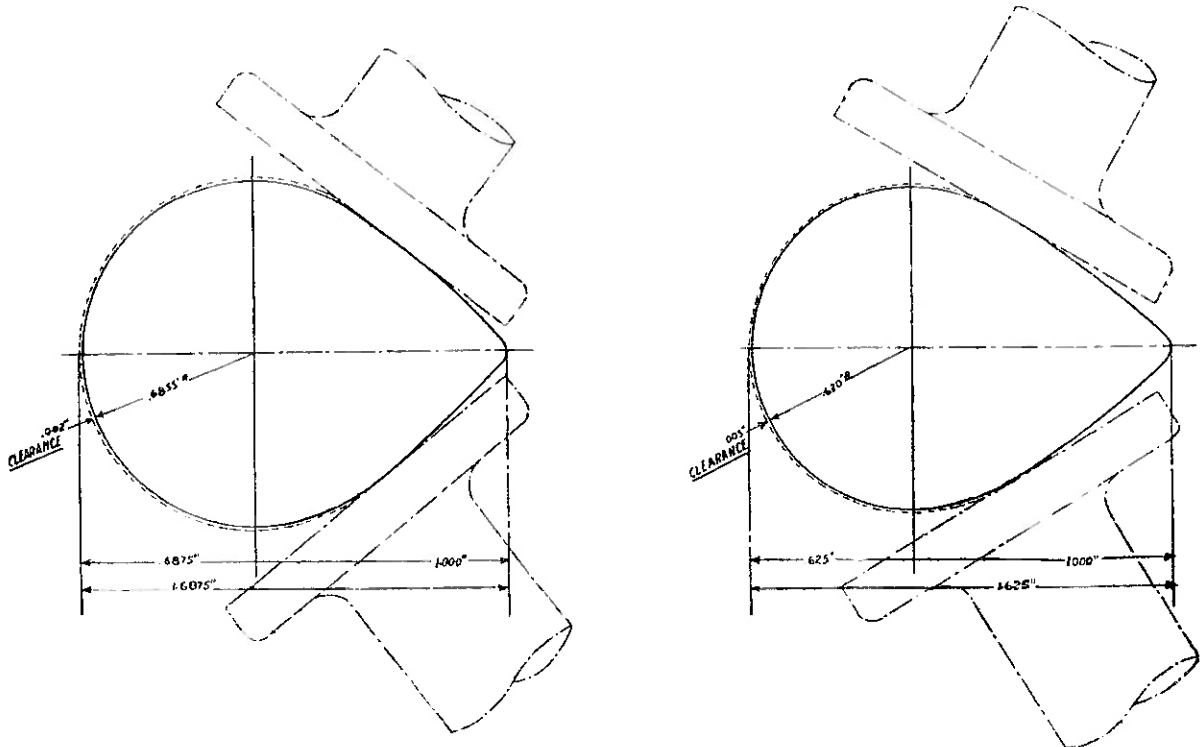
Never turn the water pump packing nuts up tight with the pump wrench. If the grease cups are full and the packing and shaft in good condition, the nuts will not have to be tightened very tight. Too much tightening will allow the packing to cut the bronze shaft sleeve. The packing used is the best suited for the purpose and none other should be used.

Checking Valve Timing

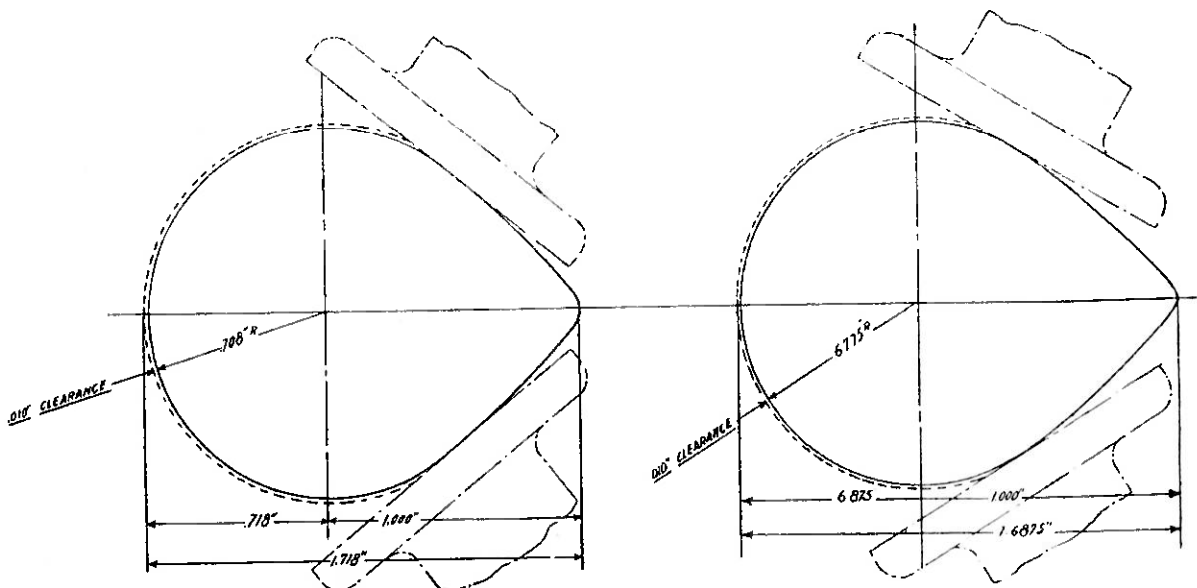
There are two types of camshafts used on BUDA engines. The old style has a base circle clearance of three thousandths of an inch and the new style a base circle clearance of ten thousandths of an inch.

The shafts are distinguished by the markings at the front end around the thrust ball.

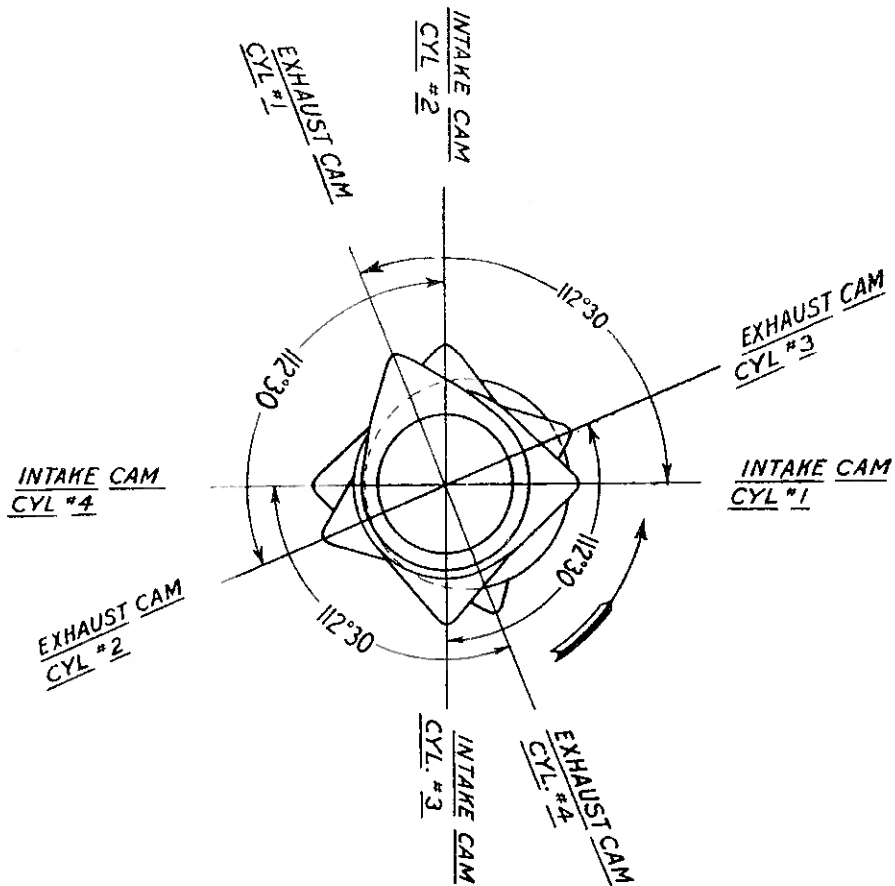
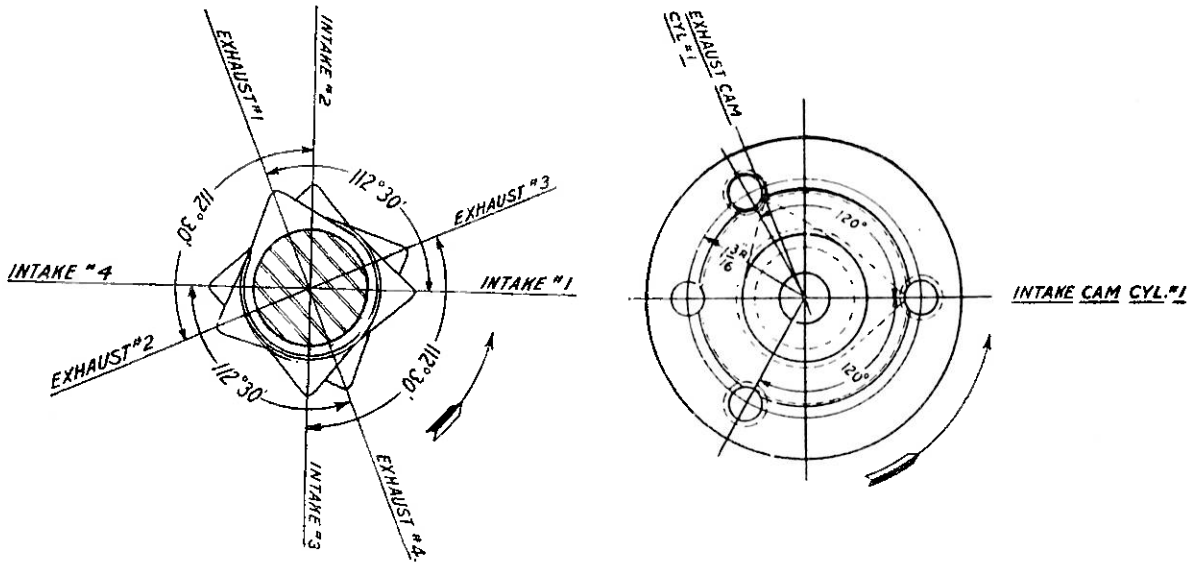
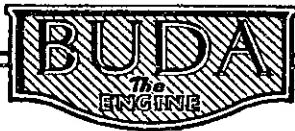
The old type shafts have no markings, but the new type are stamped ".010 cl." Both of these shafts are, however, timed for opening the intake valves at the same flywheel position. The method of timing each type of shaft is as follows:



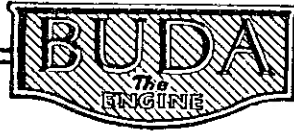
Cross Section of Old Style Cam Showing .003 Base Circle



Cross Section of New Shaft Showing .010 Base Circle



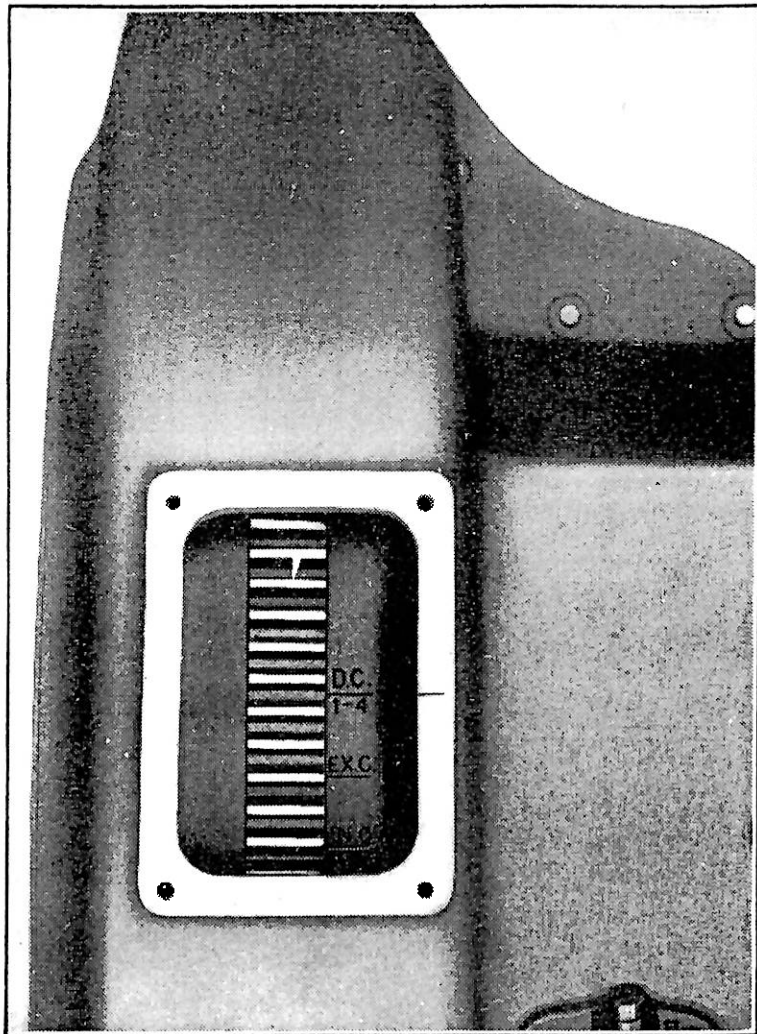
Front View of New Shaft Showing .010 CL Markings



Old Type Cam—Complete Resetting

When the point of No. 1 intake cam (the second cam from the front) is down, set the tappet for this cam with 3 thousandths inch clearance with a feeler gauge between tappet and valve stem. Turn the engine in the direction of rotation until the flywheel marking—INT. OP. 1 & 4—is in the center of the bell housing inspection hole, that is, directly up. This is the position that the intake No. 1 should just start to open.

As the cams are all integral with the shaft, it is not necessary to check more than this one. Now turn the camshaft with the gear removed, in the direction of its rotation—counterclockwise (opposite from the direction of the hands of a clock) facing the gear end of the engine—until the valve tappet clearance is taken up and the tappet adjusting screw touches the valve stem, starting to lift it. Match up the unevenly spaced holes in the gear and shaft flange and tap the gear in place. The angle of the gear teeth will turn the



Flywheel Markings Through Inspection Hole in Flywheel Housing



gear as it is rapped into place. A few trials will show just what teeth to have in mesh, to make the holes line up when the gear is in place.

Old Type Cam—Checking

When the point No. 1 intake cam (the second cam from the front) is down, set the tappet clearance 3 thousandths of an inch with feeler gauge. Turn the engine over slowly in the direction of rotation until the tappet adjusting screw tightens up on the valve stem and just starts to open the valve. Look at the flywheel marking through the inspection hole in the flywheel housing. The inspection mark will be at, or very close to, the center of the opening.

New Type Cam—Complete Resetting

This is done the same as the old type, except set No. 1 intake tappet clearance 10 thousandths of an inch instead of 3 thousandths of an inch.

New Type Cam—Checking

This is done the same as the old type, except set No. 1 intake tappet clearance 10 thousandths of an inch instead of 3 thousandths of an inch.

All flywheels are marked for timing before leaving the factory, so the marks will come in the same location on all wheels.

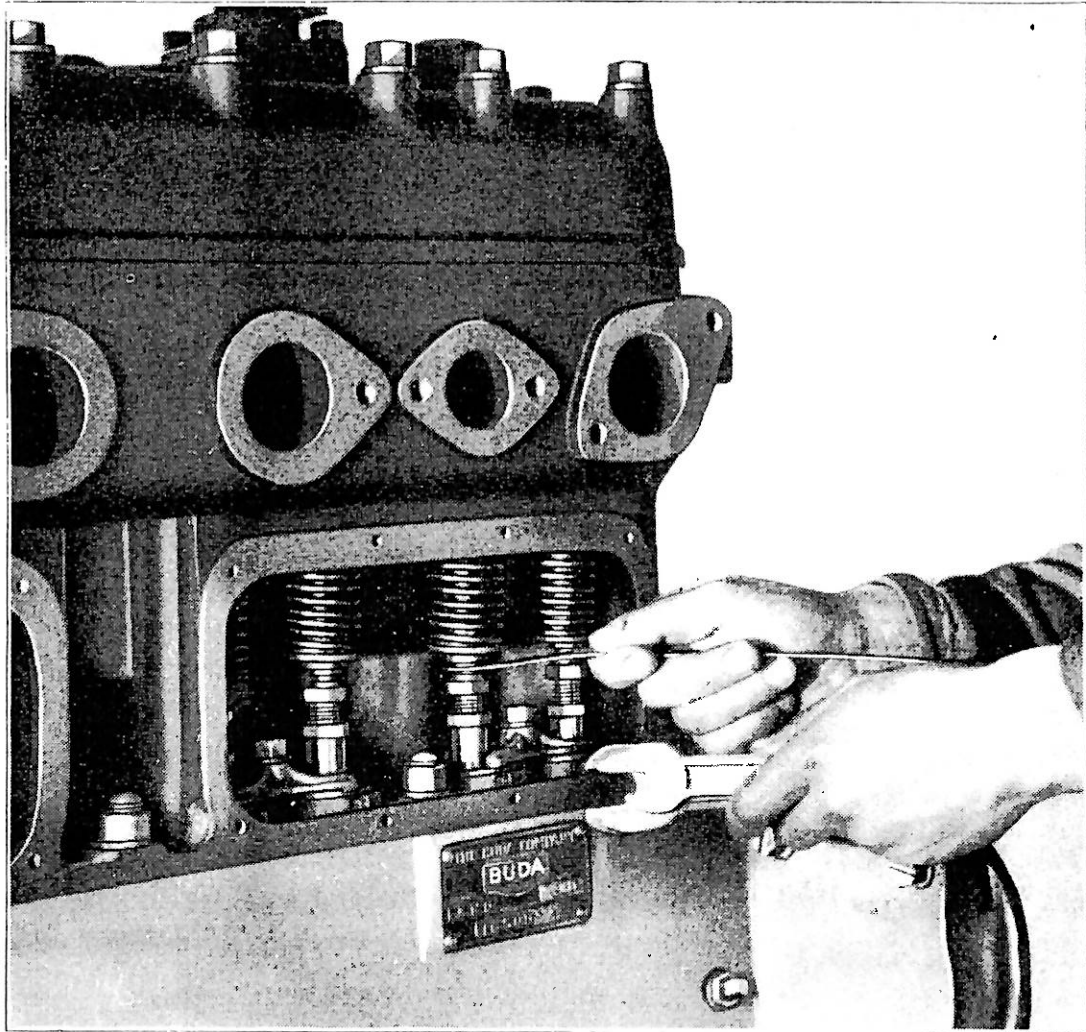
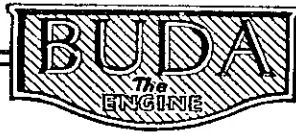
When the camshaft is in place and the timing correct, the tappet clearance should be checked and reset on *all* valves according to the clearances given under the heading "Tappet Clearance."

Tappet Clearance.

It is very important that the engines have, at all times, clearance between the tappets or push rods and the valve stems. A set of feelers or strips of spring steel of the correct thickness should be obtained and kept for this purpose. These feeler strips may be obtained from dealers or BUDA parts stations.

The recommended clearances, set when the engine is cold, are for the various BUDA models as follows:

Up to 4½-inch bore	8 thousandths on intake.
	12 thousandths on exhaust.



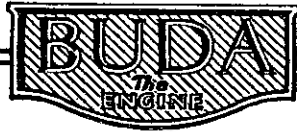
Feeler Strip Under Valve Stem

4½-inch bore and up through 5-inch
bore 10 thousandths on intake.
16 thousandths on exhaust.

Check the clearances each week and reset the tappets when necessary.

To Adjust Oil Pressure.

See that the oil is in good condition, that it has the proper body and has not thinned out. Heat the engine up until the oil is at its natural running temperature. If there is not an oil pressure gauge



connected to the engine, screw one into the main oil line. There is a $\frac{1}{8}$ inch pipe plug behind the carburetor for this purpose. Run the engine at about 1000 revolutions per minute.

If the pressure is above 15 pounds on the gauge, unscrew the plug screw at the top of the pressure relief valve a few turns (see cut, page 17) until the pressure drops to about 15 pounds. Then the space under the head of plug screw may be measured, the screw removed, washers of the thickness of this measurement slipped over it, and the screw put back in place.

If the pressure is below 15 pounds, several of the thin washers that will be found under the head of the plug screw may be removed, then the plug replaced.

Throttle the engine down to idling speed. The pressure should now be between 5 and 10 pounds. If it is much below 5 pounds, the oil is escaping past the valve or bearings faster than it should. Sometimes a little dirt under the ball of the valve will cause low oil pressure.

The ball may be removed for the inspection of the seat by taking out the plug screw and spring, and lifting the ball with a magnet made from a small round file.

Genuine Parts.

There is nothing mysterious or complicated in the design or construction of the BUDA engine. Service adjustments call for the use of common sense and a slight mechanical skill. Service maintenance and service repairs call for a greater degree of mechanical skill and if you do not feel competent to attempt them it would be wiser to have the work done by an experienced mechanic.

There is one thing, however, which it will pay you to watch and that is the replacement of worn out parts. *Particularly where new pistons, pins, rings, or bearings are fitted, you should make sure in your own interest that these parts are of genuine BUDA manufacture and not cheap imitations or substitutes for the real article.* The popularity and wide distribution of our engines has caused a host of illegitimate or "Pirate" parts makers to spring up all over the country. They are not interested in quality and their only argument is price.

The use of PIRATE or non-genuine engine parts may save a small sum on a repair bill and yet cause the whole job to be done over again



in a very short time. For your protection in this matter, we are marking all our spare parts with our trade mark, "BUDA" or our part number and you should accept no other. There are no "just as goods."

In addition to this the application of "PIRATE" parts voids our guarantee and responsibility for the successful operation of the engine, after these "PIRATE" parts have been installed, will not be borne by us.

IV. Diagnosis of Engine Trouble

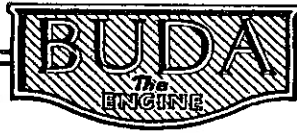
It is always well when the engine does not run properly to go over its accessories very thoroughly before attempting any adjustment or repairs on the engine proper. When you do locate the trouble, do not experiment if you do not know how to correct it. If you have made a wise selection you will find that your engine is equipped with the better known devices such as carburetors or magnetoes that are the product of manufacturers who maintain service stations for just this reason. The very fact that they have these service stations shows their willingness to back up their product.

In the course of our many years of experience in the manufacture of engines we have had frequent occasion to give service direct to operators who claim there was something wrong with the engine, that it was deficient in power and so on. The Service Department of this company had occasion recently to analyze the reports covering the calls made in one year. In considerably over ninety per cent of the cases it developed that the whole cause of the complaint was due to defects in spark plugs, cooling systems, or lack of adjustment in the governor, carburetor, or ignition system. In too many of the other cases the trouble was due to improper oil and no periodical inspection of valve tappets.

Testing Compression.

The power and smooth operation of an engine depends upon good even compression in all cylinders.

To test the compression, the most practical way is to warm the engine up, shut it off, then turn the crank slowly. When one of the cylinders is under compression, allow the crank to rock back and



forth. If the crank springs back and forth continuously, without any loss of the spring action, the compression is good. If the spring action dies out in two or three rockings, the compression is poor and the valves are probably not seating properly. If regrinding the valves does not help the situation any, then the piston rings must be causing the leakage and they should be examined. The above test should be made on all of the cylinders. By opening all of the priming cocks, except the one in the cylinder being tested, the poor cylinders may be detected.

Backfiring Under Load.

Adjusted to lean.

Has dirt or water in gasoline line or in float chamber of carburetor.

Gasoline supply low.

Engine not properly warmed up.

Spark plug wires mixed.

Valves sticking or not seating properly.

Ignition or valve timing incorrect.

Air leak in intake manifold or gasket.

Engine Loads, Slow Pick-up, Black Exhaust.

Carburetor set too rich.

Choke is closed or partly so.

Vacuum tank float sunk.

Gasoline float valve stuck open—watch for flooding.

Engine Stalls at Idling Speed.

Carburetor set too lean.

Throttle stop screw not adjusted properly, allowing throttle to close too far.

Spark weak, retarded too far, or plug gap too great.

Leaky valves.

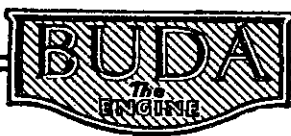
Air leak in intake gaskets.

Cold engine.

Engine Overheats.

Check ignition timing.

See that full retard and full advance are obtained when moving control lever.



Lean mixture.
Rich mixture.
Dirty radiator.
Loose or greasy fan belt.
Water pump inlet hose is sucked shut at higher engine speeds.
Insert coil spring in hose or use a stiffer hose.

Engine Hard to Start.

Dirt or water in carburetor or gasoline.
Weak spark—burned or pitted breaker points.
Defective spark plug wires.
Spark plug gaps too wide or plugs fouled.
Air leak in intake manifold.
Carburetor choke valve not adjusted to obtain full choke.
Cylinders flooded with gasoline.

Spark Advanced too Far.

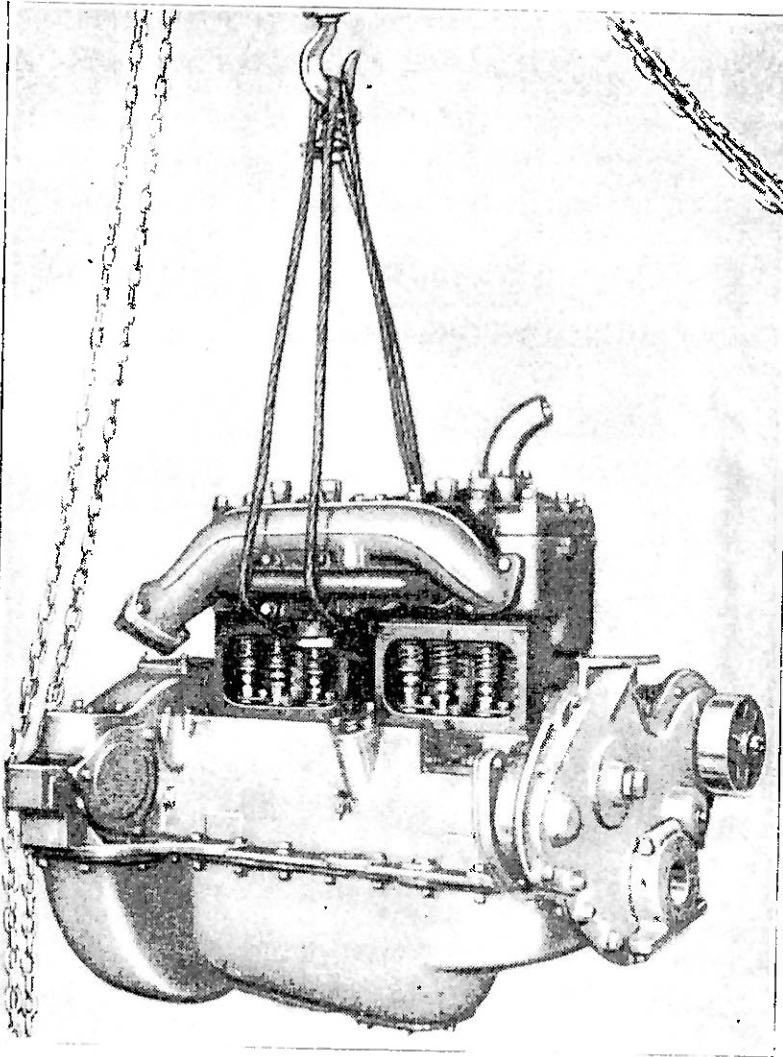
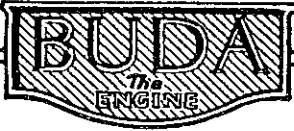
Overheating of engine.
Excessive spark knock.
Engine kicks back when cranking.
Slight loss of power.
No difference in idling speed when fully advanced or retarded.

Spark Retarded too Far.

Overheating of engine.
Considerable loss of power.
Stalling of engine at low speeds.
Slow pick-up.

V. Dis-assembly and Inspection of Engine for Complete General Overhauling

REMOVE the radiator, fan, fan belt, bracket, wire tube, water outlet, spark plugs, priming cocks, breather pipe, water pump, grease cups, bayonet gauge and tube, electrical equipment, carburetor and any other accessory that may get damaged in removing the engine. The transmission may be removed also, if more

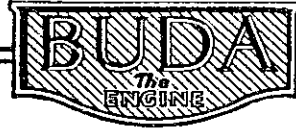


Method of Lifting Engine with Wire Sling

convenient. For the lighter engines use a heavy rope or wire sling and pass this under the cylinder water jacket between the second and third cylinders. In the heavy models use a heavy rope or wire sling under each end of the engine and fasten to a chain fall above the center of the cylinder block. If many engines are to be removed, it will pay to make up a pair of forged eye rings and thread the ends to fit the two

threaded holes on the top of the cylinder head. When these rings are in place, pass a heavy bar or piece of timber through the eyes and hook the chain fall around the bar at the center.

After the engine is removed and the oil drained, clean the exterior with a putty knife, gasoline and a stiff brush. Next obtain several clean boxes for small parts, cap screws and bolts. Clean off a good sized bench, one end of which may be used for storage of parts until wanted.



Dis-assembling the Engine

Remove oil pan and bell housing.

Remove connecting rods and pistons.

Remove crankshaft and flywheel.

Remove oil pump.

Remove cylinder head.

Invert engine and remove water pump.

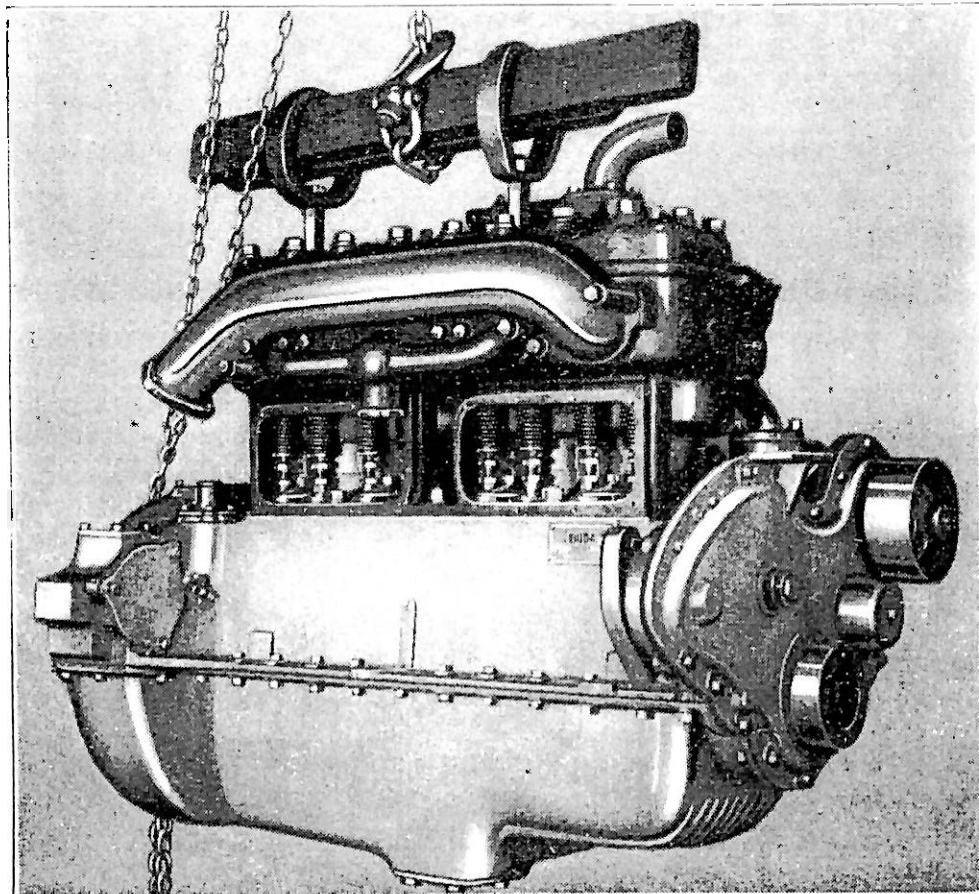
Remove cylinder block.

Remove valves, valve springs and push rods.

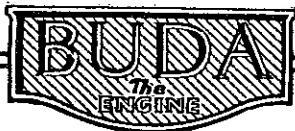
Remove camshaft and gears.

Inspection of cylinder block, pistons, push rods, etc.

First remove oil pet cock from side of oil pan, then turn it upside down and place a piece of timber crosswise under each end of the cylinder head so the engine will be steady.



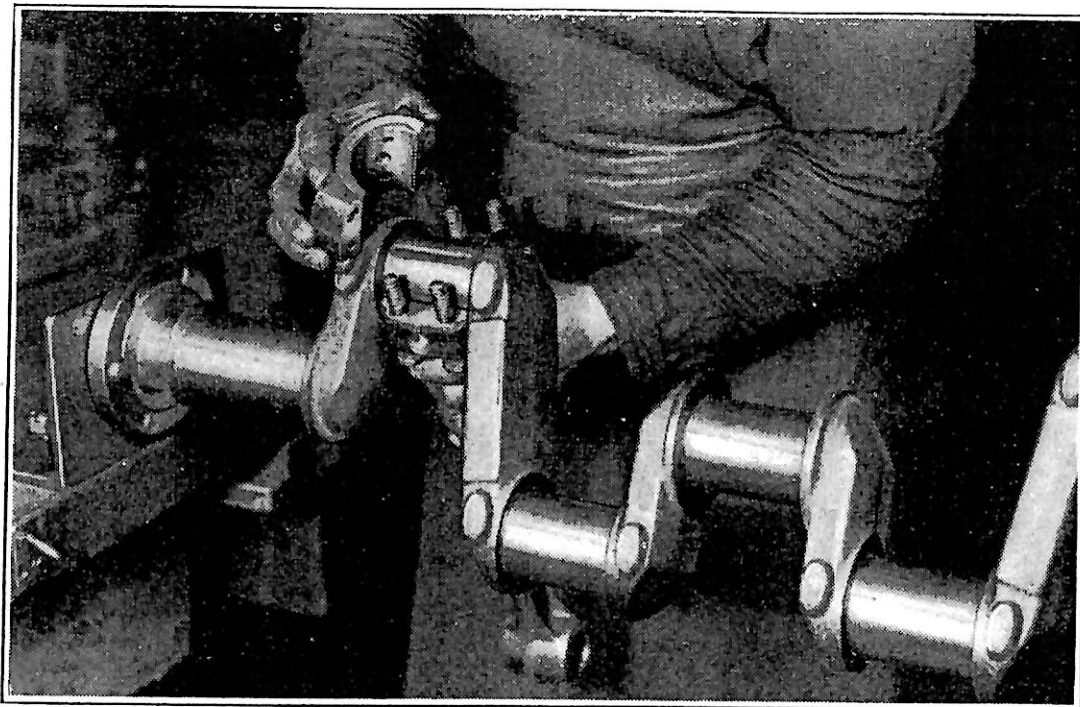
Method of Lifting Engine with 2 Eye Hooks



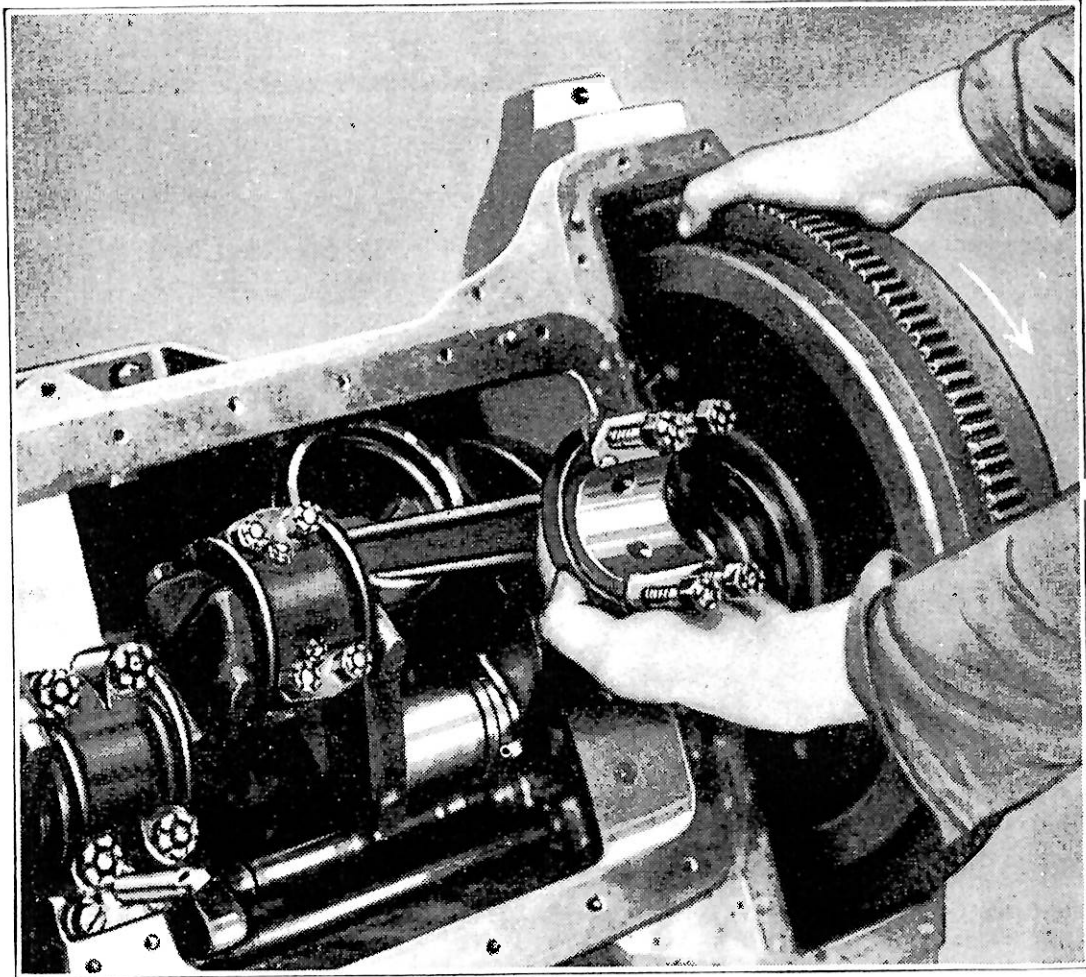
Oil Pan and Gear Cover.

After removing the fan pulley nut, the pulley may be removed with a small puller. The pulley key may then be knocked out and the gear cover removed, washed up and set aside. As the cover is removed, care must be taken not to loosen the pulley shaft oil thrower which will drop from the pulley shaft. Note the way this thrower comes off, so it may be replaced correctly. The large end should face out toward the front. Remove the small plate on the bottom of the oil pan and take out the oil screen. Wash the screen, plate and cap screws and set aside. Remove all oil pan and gear cover bolts, and cap screws. Drive out the two taper pins in the pan flange, driving from the bottom of the engine toward the top. Drive out the two taper dowel pins in the gear cover flange.

The oil pan may now be lifted off. Care should be taken not to tear the gasket or the cork strip at the flywheel end. The inner splash pan should be taken out and the whole oil pan cleaned thoroughly, then the splash pan replaced. The bolts, capscrews and dowels of the



Holding Rod Bolts in Removing Rod

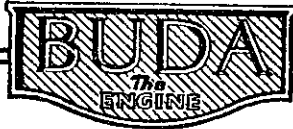


Removing Piston and Rod from Counterbalanced Engine

cover and pan should be washed and placed in a box by themselves. Next remove the lower half of the bell housing or flywheel cover, clean up and set aside.

Connecting Rods and Pistons.

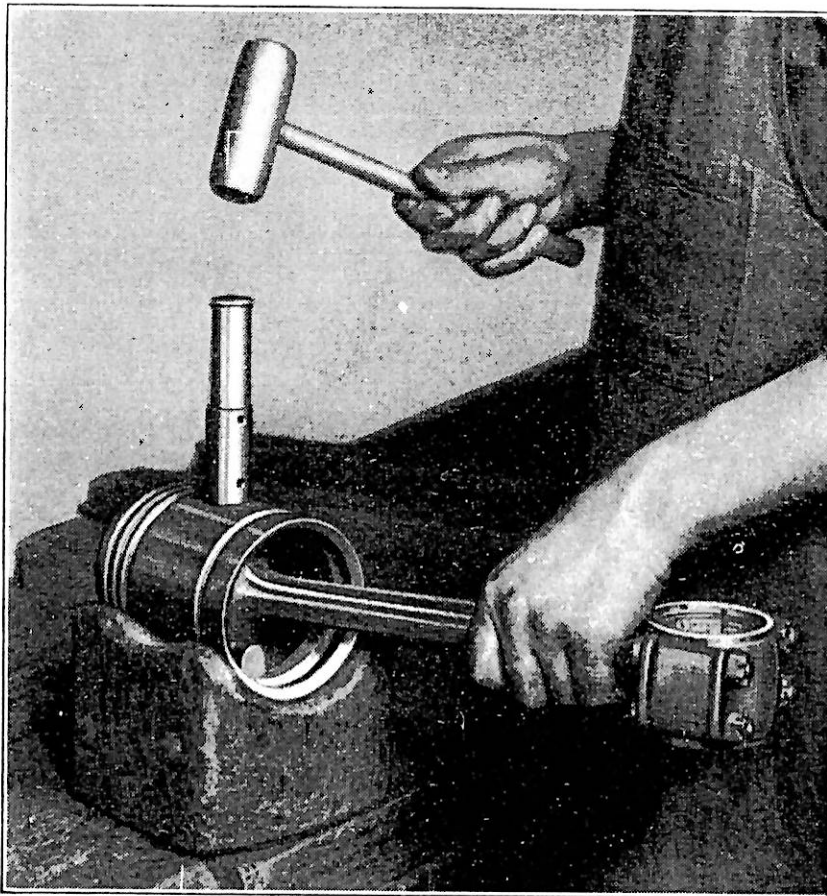
Before removing the connecting rod bolts and bearing caps, make sure that the cylinder numbers are stamped on the connecting rod bolt bosses of the rods and caps, on the apposite side from the camshaft. These numbers are on all rods when the engines leave the



factory, but rods may have been replaced in service. In removing the connecting rod caps from the rods do not take the bolts out of the connecting rods, and hold all shims to the bolts while the cap is being removed as illustrated on page 36, then examine the caps to see that none of the shims are stuck to it. Replace each nut on the bolt from which it was removed.

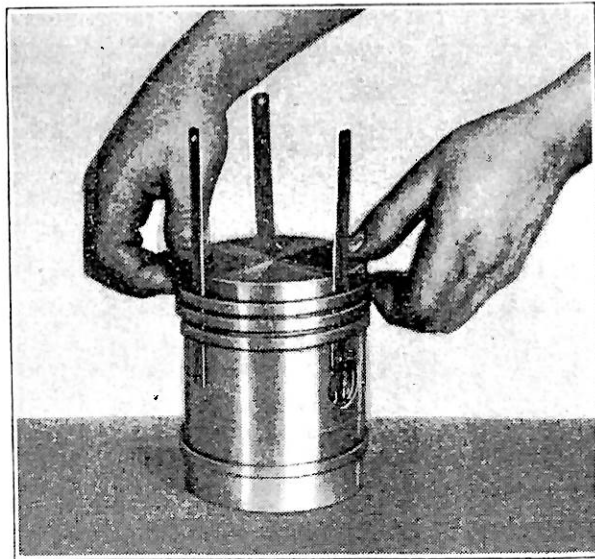
In engines using counterbalanced crankshaft weights, pistons may be removed by the opposite side from the camshaft by letting the pistons follow the counterbalanced weights as the crankshaft is turned in its normal direction of rotation. Pistons and rods may be replaced in a manner exactly vice versa.

Remove the piston pin set screws and the spring wire locks at each end of the pins, then drive the pins out with a small brass bar.



Replacing Piston Pin with Piston on Wood Block

To remove the piston rings, take three narrow strips of sheet metal or old hack saw blades and insert them down behind the top ring having one of them at each end of the ring joint and locating the third strip on the opposite side from the ring gap. This will form a skid over which the ring may be slipped on or off the piston. Repeat this process with the other rings. In case the rings are to be used again, keep them separate in such a manner that they will be put back in the same grooves. Clean all parts and set aside. If bushings and pins are badly worn, new oversize pins should be used. These oversized pins can be obtained in sizes 5, 10, 15 and 20 thousandths oversize at dealers and BUDA parts stations. If the wrist pin bushings are loose in the rods, they should be removed by pressing or pounding out with a bar.



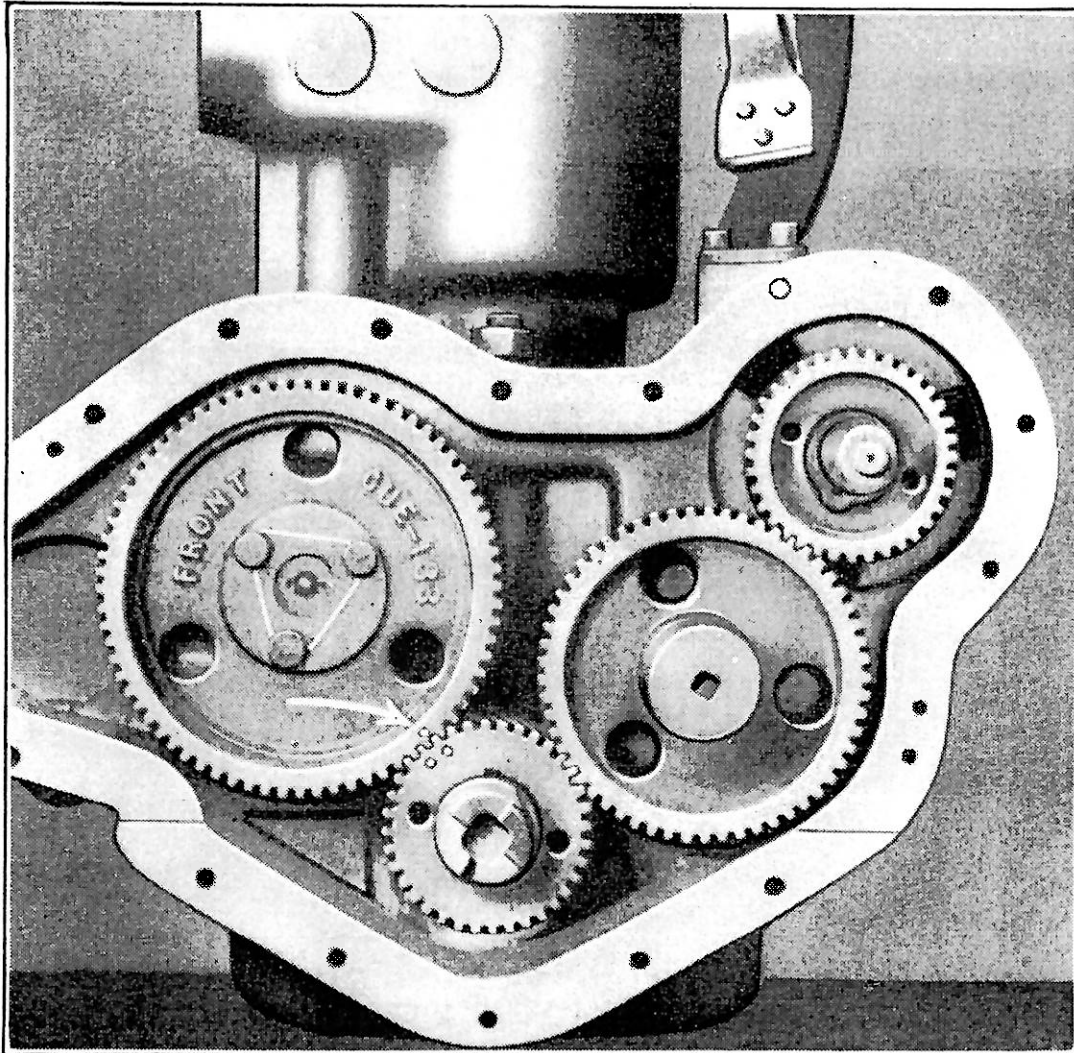
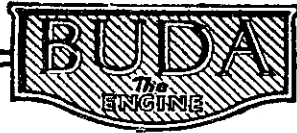
Removing Piston Rings with Skids

It is necessary to remove the oil pump drive shaft before attempting to remove the camshaft.

Crankshaft and Flywheel.

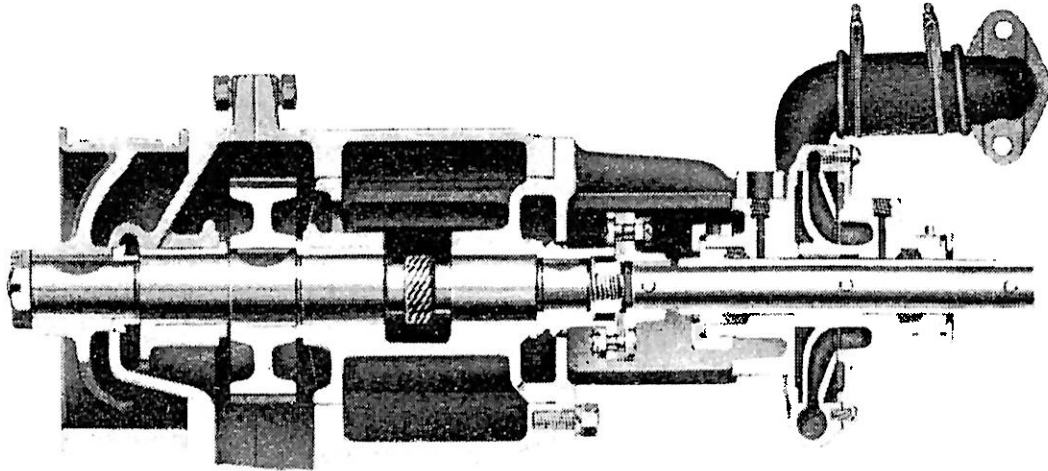
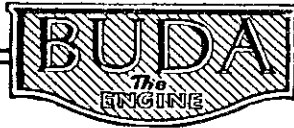
See if the crankshaft and camshaft gears are marked for timing. There should be center punch marks on the ends of two teeth of one gear and on the end of one tooth of the other. If there are none, mark the teeth that are in mesh in this manner. As shown on page 40.

Remove the main bearing caps and lift out the crankshaft and flywheel. Replace the caps, making sure the shims are in place. If the bearings are in good shape and are to be used again, the flywheel need not be removed, but in case new bearings are to be fitted, the wheel should be unbolted. The bolts will be found to be a tight fit, so care should be taken in pounding them out that they are not damaged.



Gear Train Showing Marking of Teeth

Clean up the shaft and flywheel and set to one side. Caliper the crankshaft journals with a micrometer to see if they are worn out of round, or whether they have "flat spots." If any of the journals are found to be more than three thousandths out of round, it will be necessary to have them reground and fitted with new bearings, as it is impossible to keep bearings tight on journals which are out of round more than this limit.



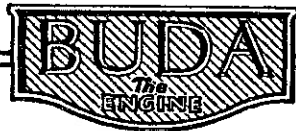
Cross Section of Water Pump Assembly

Water Pump and Water Pump Drive Shaft Housing.

Roll the engine over carefully and stand right side up on two timbers placed crosswise near the end main bearings. Remove the water pump as follows: take out the two small coupling bolts which have their nuts facing the front of the engine. Disconnect the cylinder block water inlet connection and remove the hose. Loosen the water pump set screw, then pull the pump out of the housing. The housing itself may be removed now by taking out the three cap screws in the flange. If so desired the whole pump and housing assembly may be removed in one piece, but this must be taken apart sooner or later and the method described above is the easier. Clean the pump and the housing containing the gear and shaft. Then set them aside on the bench.

Cylinder Head and Block.

Remove the cylinder head nuts and washers and place them in a box by themselves. A lug on the cylinder block and head will be found at each end. In ordinary cases, a screw driver applied between the lugs will loosen the head. Work the screw driver crosswise of the cylinder so as not to damage the gasket in case of slipping too far between the lugs. After lifting off the head the carbon should be scraped from the combustion chambers and the cylinder head set aside. Clean out all drilled water passage holes in the cylinder block and remove any dirt which will hinder circulation.



Next remove the valve enclosure cover, clean and set aside.

With a valve lifter raise the valve spring cups, letting the split retainer locks drop out. These locks should be washed and placed in a box by themselves. By centering the retainers on the stems, the valve may be lifted out, but first mark them lightly alongside the slot on the valve head with a prick punch, if they are not already marked with the numbers from 1 to 8. Do this when the valves are on their seats.

The springs and cups may then be pried off of the push rods with a screw driver, washed and placed in the retainer lock box.

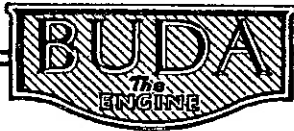
Test the push rods and see if they are sloppy in their guides. If they have but very little play, they need not be removed. If there is much play, the worn parts should be removed and discarded. By unscrewing the lock nuts and adjusting screws, the push rods may be removed from the guides. In some cases it is found that the hardened blocks in the push rod screws are found to be loose or broken, and it will be necessary to replace the screws. In all but one of the engine models covered by this booklet, the guides are held in by spiders, or crabs as they are called, and may be removed by taking out these spiders. In the model HTU engine, these guides are pressed into the cylinder block from the bottom and may be removed with a large brass bar and hammer, if a press is not available. If these guides are hammered out, the cylinder must be placed on a solid surface so as not to spring the cylinder base.

Idler Gear.

With a large wrench, or with a square bar (depending on the style of nut), unscrew the brass plug or nut from the end of the idler gear stud. This plug has a *left* hand thread and unscrews clockwise. Test the gear on the stud. If the bushing is not loose on the stud or in the gear and if the teeth are in good shape, wash it up and place it on the bench out of the way. If it is worn badly it should be discarded.

Camshaft and Bushings.

Test the camshaft for fit in the bushings. If there is no play the bushings need not be removed. Pull the shaft out, leaving the cam gear on if it is in good shape, and wash it up. If the gear is not in good



Next remove the valve enclosure cover, clean and set aside.

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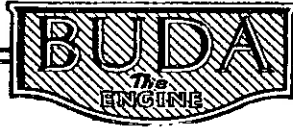
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Camshaft and Bushings.

Test the camshaft for fit in the bushings. If there is no play the bushings need not be removed. Pull the shaft out, leaving the cam gear on if it is in good shape, and wash it up. If the gear is not in good



shape, remove it as a new one must be used. If the bushings are to be removed on account of being worn, a brass dowel pin will be found in each one. These were inserted from the outside of the crankcase, and may be driven on through with a punch. When these are out, the bushings may be knocked out with a hammer and brass bar. The plate covering the oil pocket of the rear bushing in the bell housing should be removed with a screw driver for cleaning purposes. In newer models and expansion plug is used, in place of this plate, and this should not be removed.

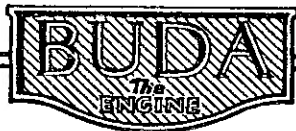
Cleaning Crankcase and Cylinder Block.

Stand the crankcase bottom up on some boards out of doors or over a large pan and scrub the sticky oil and carbon from the inside with a stiff brush and gasoline. Remove this material from all corners and flush the oil lines with clean gasoline. An oil squirt gun filled with gasoline is a good thing for flushing out the lines. If compressed air is not available, the oil lines may be blown out with a foot tire pump. The cylinder block should be scraped free of carbon and washed with gasoline. Take a bit of rag on a wire and with a little gasoline scrub out the inside of the valve guides. Now try the valve stems in them and if they are too loose the guides should be replaced. They may be knocked out with a brass bar and hammer, pounding down from the top.

Inspection of Cylinders and Pistons—Regrinding.

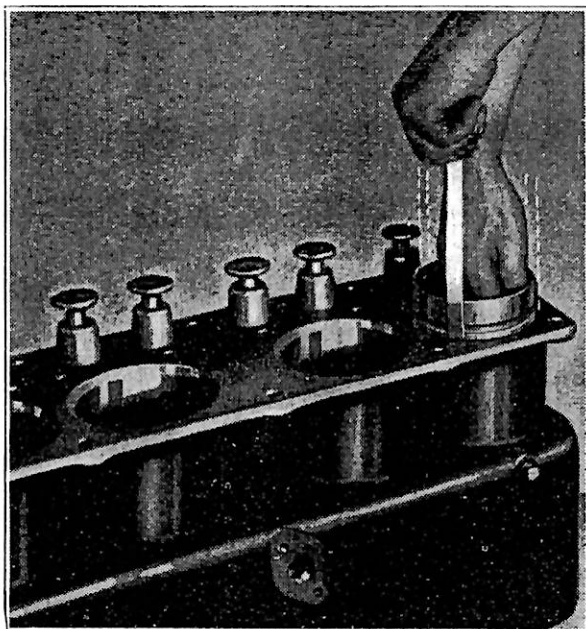
The cylinders may be checked for wear with an inside micrometer, taking measurements in all positions the whole length of each cylinder. The pistons may be checked with an outside micrometer in several points below the third ring. If these instruments are not available, the piston clearance may be checked with long feeler strips.

The correct clearance for the pistons is 1 thousandth inch for each inch diameter of the pistons. For example, an engine of $4\frac{1}{2}$ -inch bore should have a piston clearance of $4\frac{1}{2}$ thousandths of an inch, or .0045 inch. To check the clearance for this engine, obtain two strips of spring steel about 1 foot long and $\frac{3}{8}$ or $\frac{1}{2}$ inch wide. One of these strips is to be 4 thousandths (.004) and the other 5 thousandths (.005) of an inch in thickness. Stand the thinner strip in one of the cylin-



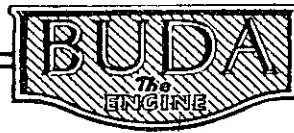
ders and pass the piston for that cylinder into the bore, so the feeler strip will be between the piston and cylinder wall. Repeat with the feeler strip in several positions around the cylinder. Now do the same thing with the thicker feeler strip. If the piston clearance is correct and the piston and cylinder are quite round, the larger feeler should be tight and the smaller one a little loose.

Most of the cylinder wear comes near the top of the cylinder. This is especially true where the top ring in the piston ends its upper stroke in the bore. Generally a heel or shoulder will show here, which to the inexperienced may appear as though excessive wear has taken place. This is not always the case as often times the wear is more apparent than real, and only the decision of a competent mechanic or service man should be accepted as a necessity for regrinding. The best method to pursue in checking these cylinder barrels for wear is by the use of inside micrometers. Where these are not available the feeler gauge method as outlined above may be used. If the cylinders are found to taper more than 5 thousandths of an inch or if the cylinders are found to be out of round they should be reground. All four cylinders should be reground the same size, and it is best to grind these either 10, 20, 30 or 40 thousandths oversize, as these are



Fitting Piston in Cyl. with Feeler Strip

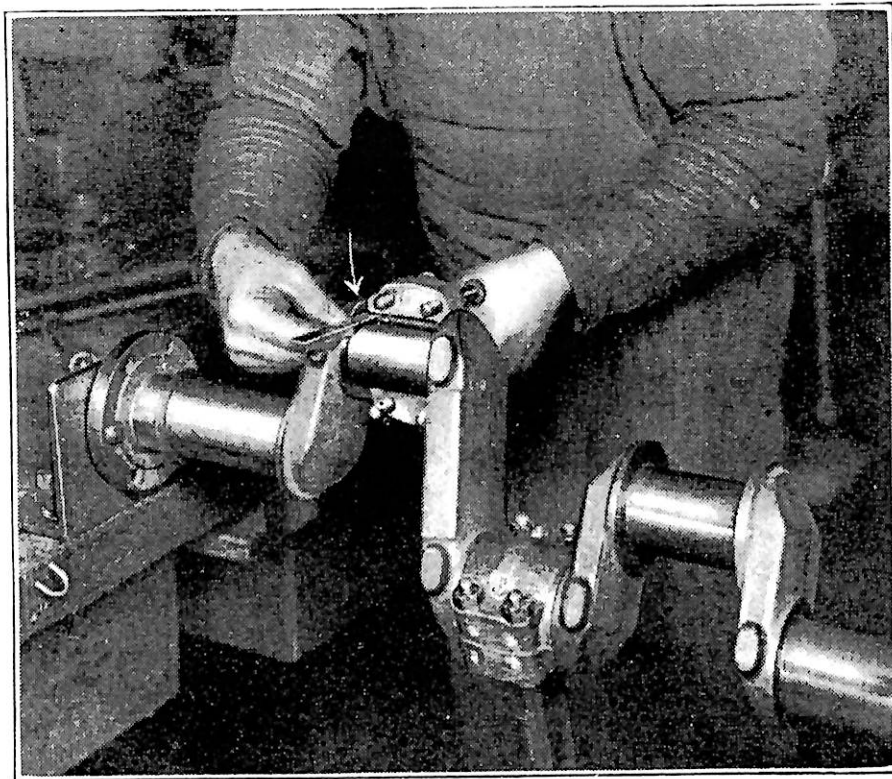
standard oversize, and the pistons are carried in stock by dealers and BUDA parts stations. After regrinding, new oversize pistons should be checked with a feeler gauge as described above. It is now our practice to stamp on the heads of the pistons the weights in pounds and ounces. All pistons are held to $\frac{1}{4}$ of an ounce tolerance in our production. In replacing one or two pistons in a repair job, care must be taken to see that the new pistons installed are of same weight as the piston removed.



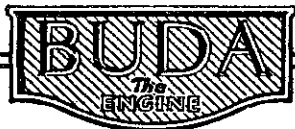
VI. Assembling the Engine

THE following is a brief outline of the best method to pursue in reassembling an engine which has been torn down for general overhauling.

1. Fit connecting rod bearings to their journals on crankshaft.
2. Fit piston pins to connecting rod bushings and pistons.
3. Install pistons on the rods without the rings.
4. Grind valves, fit push rods, etc.
5. File piston ring gap to each cylinder.
6. Check the fit of piston rings and pistons in their cylinders.
7. With camshaft in place install the cylinder block on the crankcase.
8. Fit main bearings to the crankshaft.
9. Install the flywheel.
10. Straighten the connecting rods, and line up pistons.



**Crankshaft, One Rod Assd., Another Rod Against Shaft with
Feelers Between Shim and Shaft**



11. Install connecting rod and piston assemblies.
12. Install bellhousing and oil pan.
13. Install the oil pump.
14. Install water pump.
15. Set the valve timing.
16. Set tappet clearance.
17. Adjust idler gear.
18. Install gear cover and fan pulley.

Connecting Rod Bearings and Shims

Shims.

In all engines using force feed oil system, it is very necessary that the main bearing and connecting rod shims are properly fitted to secure the proper oil pressure on the journals.

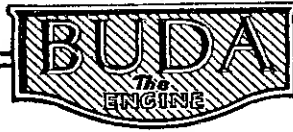
Our design calls for the brass tip on either end of these shims, which with proper fitting of .002 clearance between the point of the shims and the crankshafts, see page 45, will retain the oil within the bearing. In the event these shims are fitted with a greater clearance than .002, it leaves a passage through which the oil will be pumped. This causes low oil pressure and in many cases causes an excessive amount of oil, to be thrown against the cylinder walls, and in consequence passes the rings to form excessive carbon in the combustion chamber and on the spark plugs. It is to avoid this that the above comments are made.

In cases where old shims are found to be worn where they come in contact with the bronze bearing backs, they should be replaced with new ones.

To refit *new* shims to *old* bearings, first remove the shims from one side. Second, ascertain the thickness of these shims, and replace with new ones of exactly the same total thickness. Follow the same method when fitting the shims to the other side. After the proper thickness has been found the shim tips should be fitted in the manner mentioned on page 45. The tension when the nuts are drawn tight should be such that when the bearings are oiled they will just be snug. Old bearings should be fitted looser than new ones as they are already run in.

Connecting Rod Bearings.

In case the crankshaft journals are not found to be out of round, it would be advisable to use the old bearings after they have been



refitted. If it is found that the bronze bearing has worn until it is facing flush with the face of the connecting rod or cap, this trouble can be overcome in the following manner: Prick punch the connecting rod bearing shells so they may be removed and replaced without being mixed or turned around. Remove one bearing shell at a time. Solder a layer of babbitt or bearing metal on the face of the bearing where it comes in contact with the shims. Remove all burrs, and replace the bearing in the rod or cap. Draw-file this layer of babbitt until it is approximately 2 thousandths of an inch above the face of the connecting rod or cap. The bearing may then be tried for tension and shims removed or inserted until proper fit is obtained. It is always best to build up the bearing, rather than draw-file the connecting rod or cap facings, as it is difficult to file these correctly.

The shim faces of the connecting rod and caps are accurately machined before leaving the factory and care should be taken to keep these faces in this condition.

Scraping New Connecting Rod Bearings

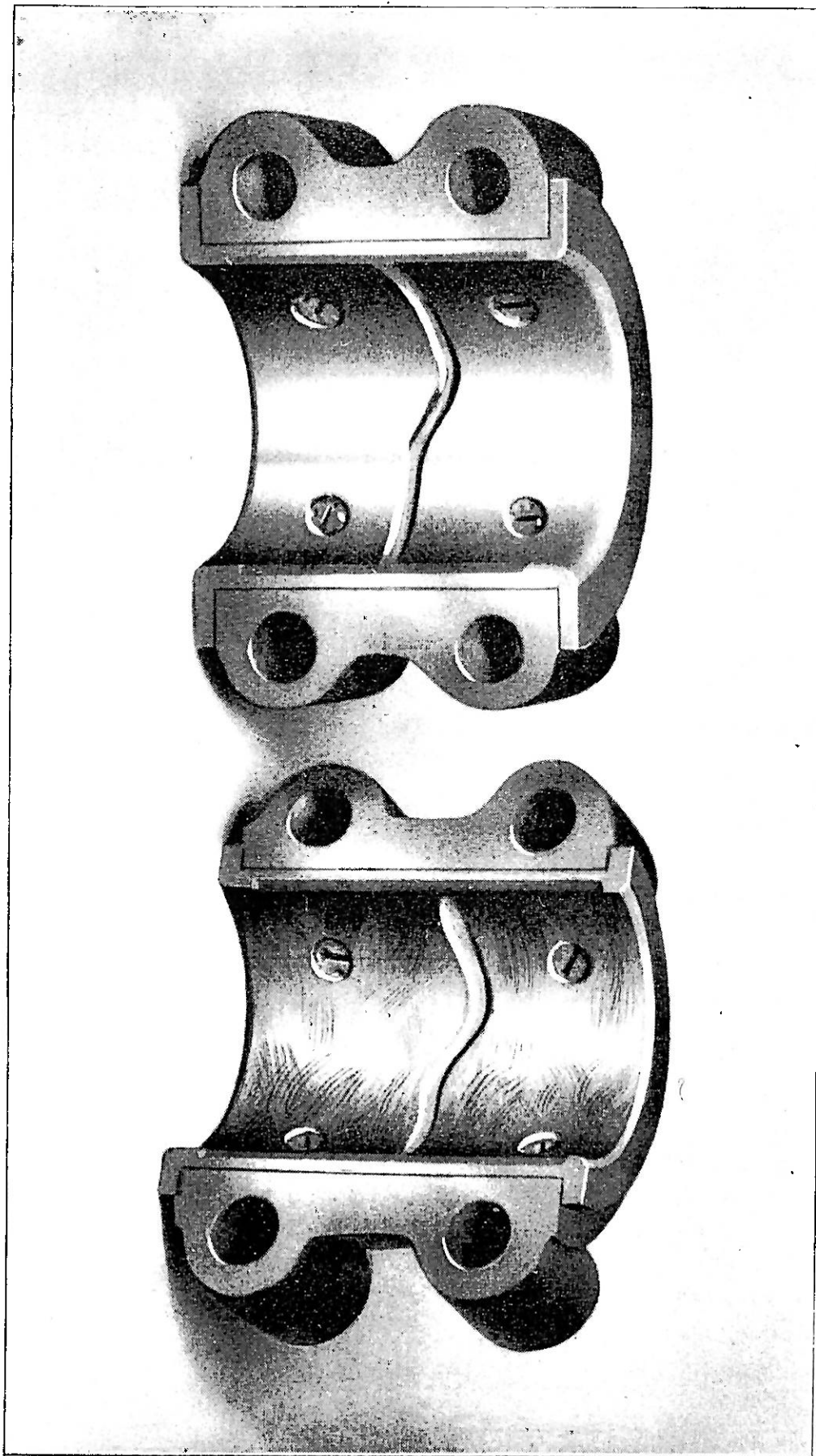
FIRST, take every precaution to see that the bearing is tightly and properly installed in the connecting rod and cap. Do not hammer the bronze bearing out of its original shape when placing it in the connecting rod. More cases of bearing trouble are caused by bearing shells fitting the rods poorly than by poor scraping of bearing surfaces.

SECOND, after the bronze bearings are installed in rods and cap, they should be draw-filed and checked against a surface plate to see that the faces are perfectly square. It is well to check each rod and each cap against the surface plate, and then check each rod and each cap together. This is important as it will cause much delay when scraping, if these points are not *carefully* worked out.

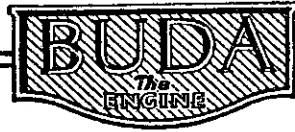
THIRD, draw-file flanges of the bearing until three thousandths end play is obtained. At the same time it is important to see that the bearing has the proper relief on the fillet. A tight fillet usually means a burned bearing on one side.

FOURTH, fit the shim tip as illustrated above.

FIFTH, the bearing is now ready to be scraped. At first the high spots are found to lie around the sides of the bearing near the shims, and the shaft will not touch the bottom, but in scraping out these



View of a Well Scraped and of a Poorly Scraped Bearing



sides great care must be taken not to extend the oil relief through to both ends of the bearings, or too much oil will escape and cause low oil pressure.

Do Not Use a File to Relieve the Side of a Bearing.

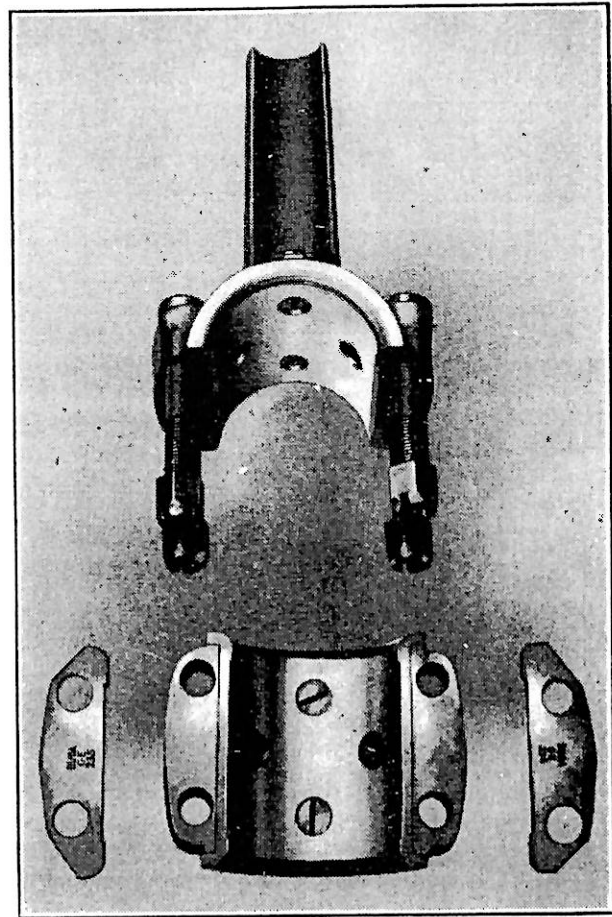
This may seem to save time, but ordinarily it means trouble. As most mechanics are familiar with scraping, little can be said of facilitate this work, other than that we have here given a photograph of a bearing as it appears when finished hand scraped at our factory. After the bearing has been scraped, all nuts should be drawn up tight to the place where the cotter pins are inserted.

Do not cut additional oil grooves in the bearings. Do not mix force feed and splash feed bearings or shims. They are not interchangeable. The oil relief extends clear through the splash bearing and does *not* in the force feed bearing.

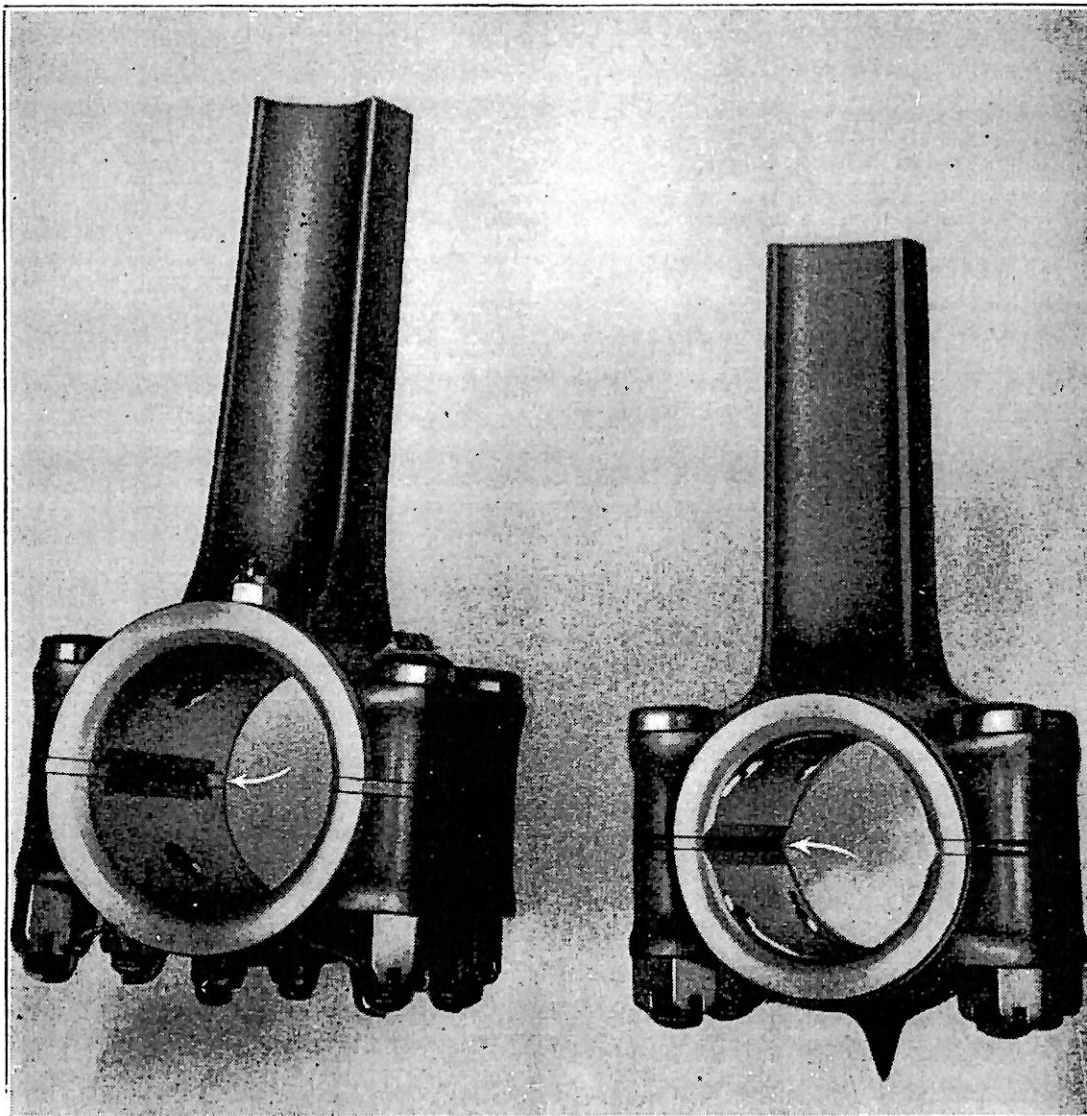
Valves and Guides.

If new valve stem guides are being installed, they may be pressed into the block from the bottom by a simple rig made of long $\frac{3}{8}$ -inch bolt and several large washers, the latter being placed over the valve seats and the bolt passed through the guides. See page 51.

In grinding valves do not use a coarse grade of compound, but a medium and a fine for finishing. Use very little compound on a valve. It is general practice in many repair shops to see how much



**Connecting Rod and Bearing
Dis-assembled**

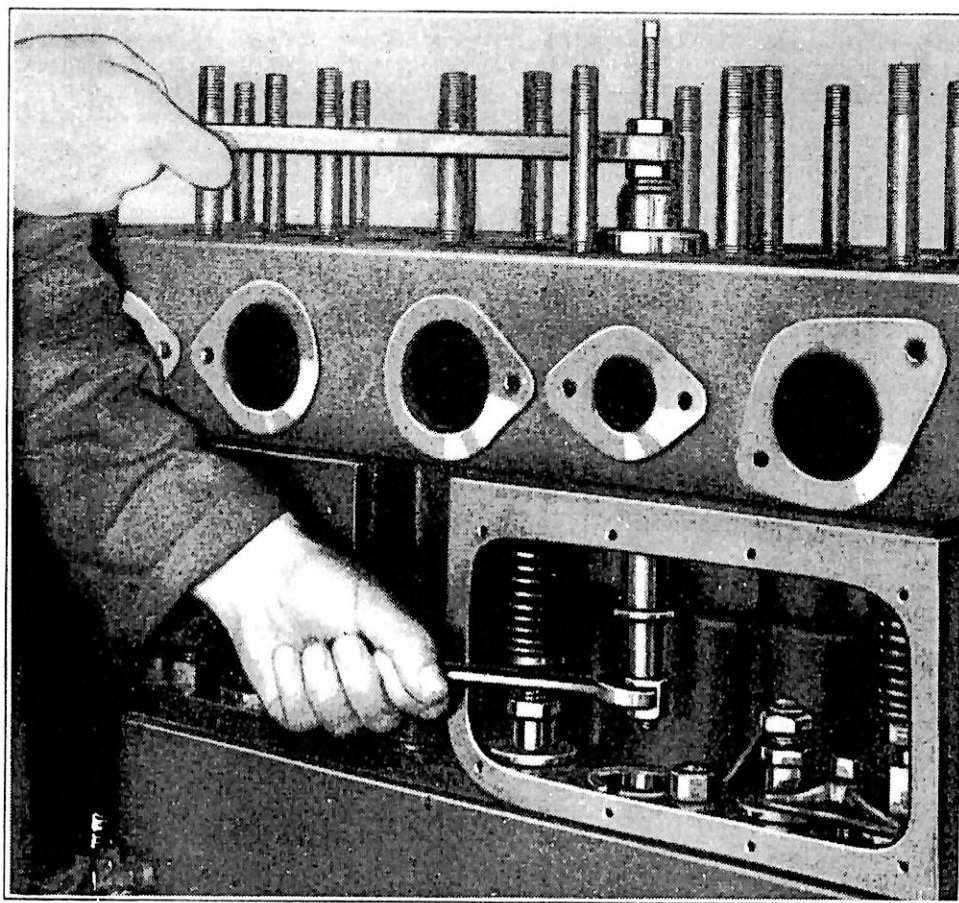


Force and Splash Rod Bearing Assemblies

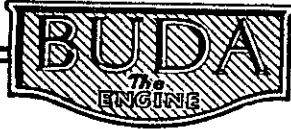
compound can be piled onto a valve. This only wastes it, allows it to get into the cylinders and does not do a good job. A very little compound smeared on the surface and ground to a polish is the best method. It is possible to get a mirror finish on the valves and seats. When this is obtained, there are two methods of testing the valve. With a pencil, make a dozen or more marks across the valve seat at regular intervals around it, then drop the valve into place and with a light pressure turn it about $\frac{1}{8}$ inch with a screw driver. Remove

the valve and if the seat is good all of the marks will be rubbed off to some extent. Another method is to cover the face of the valve with a very thin coat of Prussian blue and lower the valve into place carefully. With a very light pressure turn the valve about $\frac{1}{32}$ of an inch and then remove it. If the valve seat shows blue all around, then the grinding job is satisfactory. Clean the valves and seats with gasoline.

Put the valve springs and cups into place, oil the valve stems and drop the valves in. The easiest way to insert the split retainer locks is to place a little cup grease inside of each half and stick one-half at a time to the valve stem in the proper place, while the valve lifter is holding the spring and cups up. The spring and cups may then be lowered slowly into place.



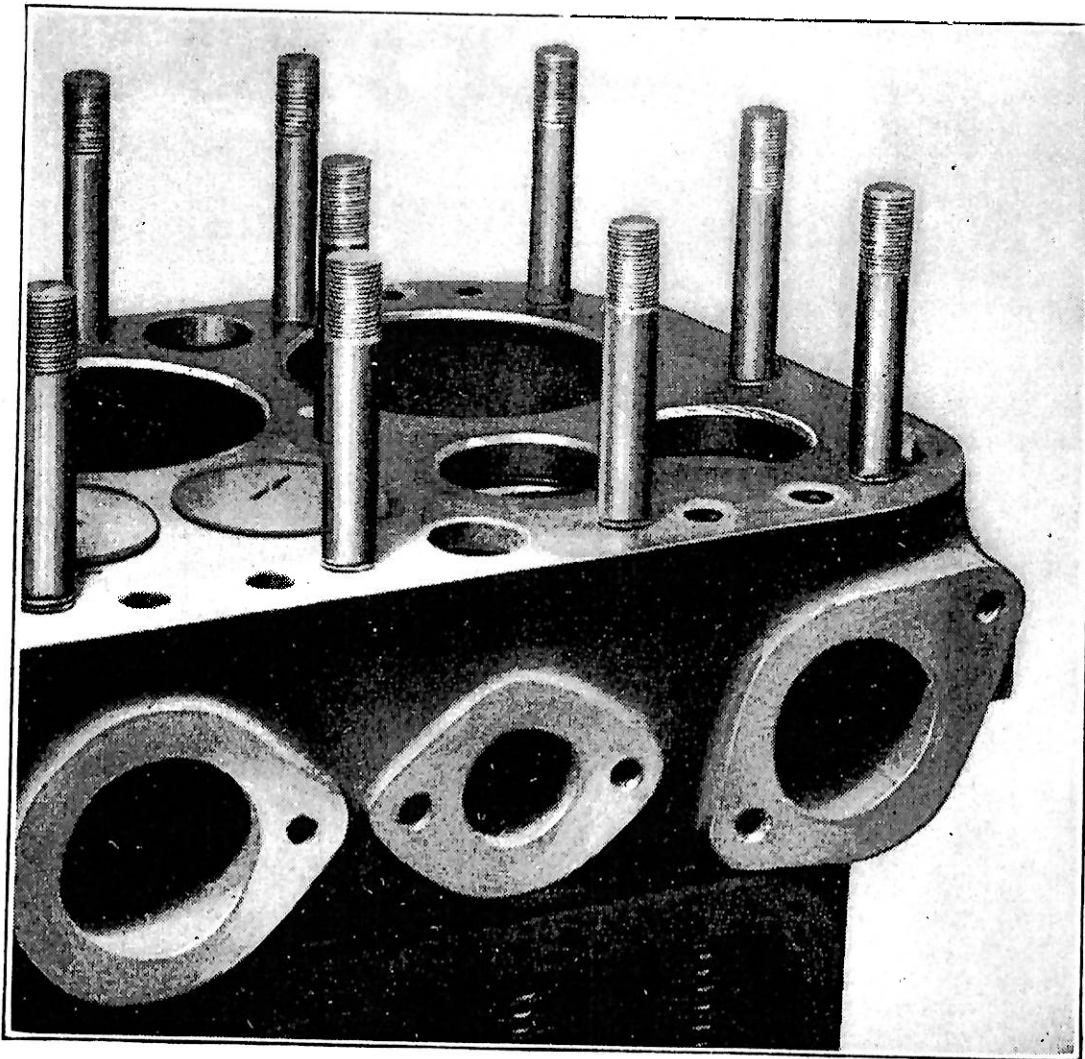
Pulling Valve Guides in Block with $\frac{3}{8}$ " Puller



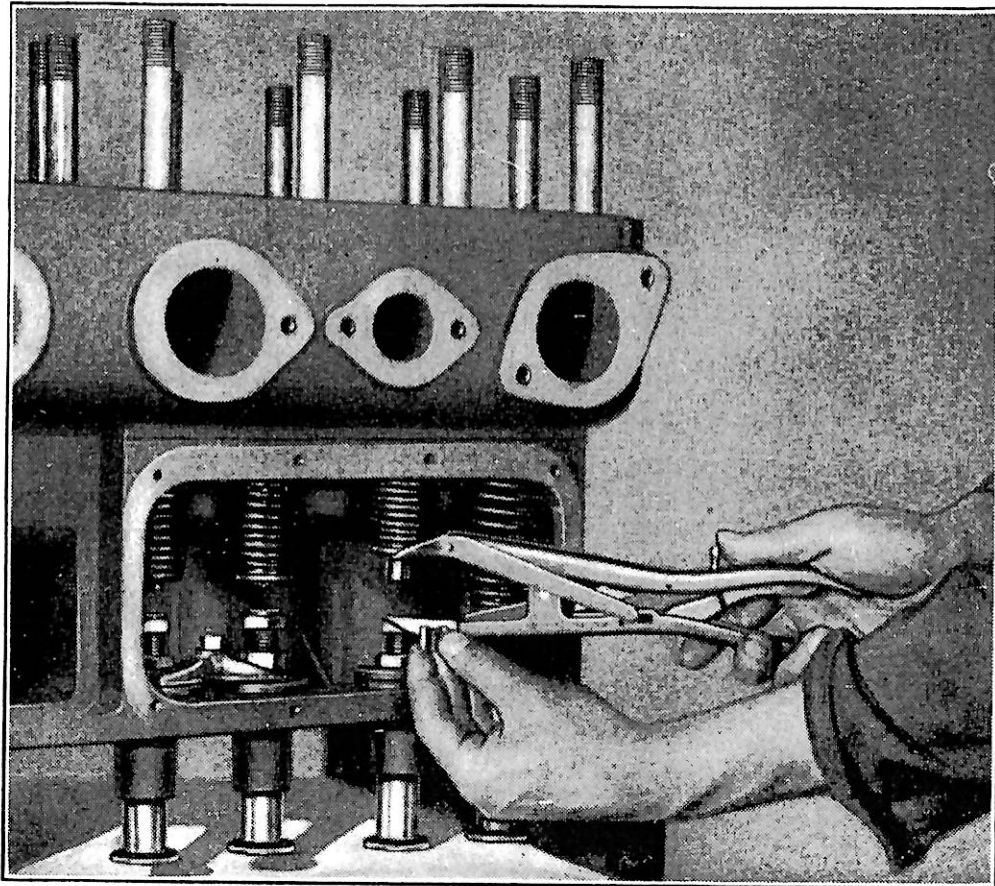
Before putting the cylinder block on the crankcase it would be best to temporarily install the cylinder head to protect the studs. This has to be removed after the engine is completely reassembled for the purpose of removing any accumulation of dirt.

Push Rods.

Drop the push rod guides into place, pun on the crabs and tighten down. In the HTU model the guides are pressed in and no crabs are used. Insert the push rods or lifters after oiling them. Make sure they are free in the guides, then insert the adjusting screws into each.



View of a Poorly Ground and of a Correctly Ground Valve Seat



Replacing Split Retainer Locks with K. D. Valve Lifter

Before assembling the pistons to the connecting rods, it is always best to check the pistons in the cylinders to see that proper clearance has been obtained.

Wrist Pins.

The wrist pins must be driving fit in the pistons. This is important as a loose pin will soon oscillate and cut the retaining screw if it is loose in the piston. It is customary to place the wrist pin screw side of the piston to the front end of the engine and the cylinder number side of the rod toward the opposite side from the camshaft.

In order to install the piston pin lock screws, it is necessary that the holes in the piston pins line up exactly with the holes in the piston pin bosses.

1870. 1871. 1872. 1873. 1874. 1875. 1876. 1877. 1878. 1879. 1880.

1881. 1882. 1883. 1884. 1885. 1886. 1887. 1888. 1889. 1890. 1891.

1892. 1893. 1894. 1895. 1896. 1897. 1898. 1899. 1900. 1901. 1902.

1903. 1904. 1905. 1906. 1907. 1908. 1909. 1910. 1911. 1912. 1913.

1914. 1915. 1916. 1917. 1918. 1919. 1920. 1921. 1922. 1923. 1924.

1925. 1926. 1927. 1928. 1929. 1930. 1931. 1932. 1933. 1934. 1935.

1936. 1937. 1938. 1939. 1940. 1941. 1942. 1943. 1944. 1945. 1946.

1947. 1948. 1949. 1950. 1951. 1952. 1953. 1954. 1955. 1956. 1957.

1958. 1959. 1960. 1961. 1962. 1963. 1964. 1965. 1966. 1967. 1968.

1969. 1970. 1971. 1972. 1973. 1974. 1975. 1976. 1977. 1978. 1979.

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1991. 1992. 1993. 1994. 1995. 1996. 1997. 1998. 1999. 2000. 2001.

2002. 2003. 2004. 2005. 2006. 2007. 2008. 2009. 2010. 2011. 2012.

2013. 2014. 2015. 2016. 2017. 2018. 2019. 2020. 2021. 2022. 2023.

2024. 2025. 2026. 2027. 2028. 2029. 2030. 2031. 2032. 2033. 2034.

2035. 2036. 2037. 2038. 2039. 2040. 2041. 2042. 2043. 2044. 2045.

2046. 2047. 2048. 2049. 2050. 2051. 2052. 2053. 2054. 2055. 2056.

2057. 2058. 2059. 2060. 2061. 2062. 2063. 2064. 2065. 2066. 2067.

2068. 2069. 2070. 2071. 2072. 2073. 2074. 2075. 2076. 2077. 2078.

2079. 2080. 2081. 2082. 2083. 2084. 2085. 2086. 2087. 2088. 2089.

2090. 2091. 2092. 2093. 2094. 2095. 2096. 2097. 2098. 2099. 2100.

2101. 2102. 2103. 2104. 2105. 2106. 2107. 2108. 2109. 2110. 2111.

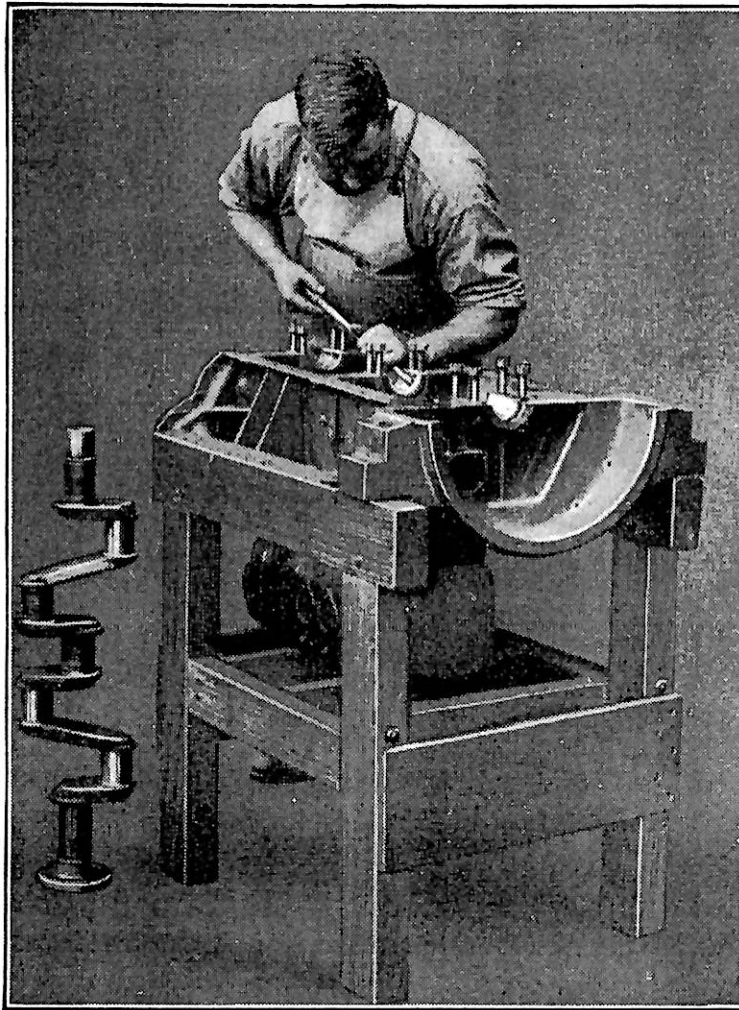
2112. 2113. 2114. 2115. 2116. 2117. 2118. 2119. 2120. 2121. 2122.

2123. 2124. 2125. 2126. 2127. 2128. 2129. 2130. 2131. 2132. 2133.

2134. 2135. 2136. 2137. 2138. 2139. 2140. 2141. 2142. 2143. 2144.

2145. 2146. 2147. 2148. 2149. 2150. 2151. 2152. 2153. 2154. 2155.

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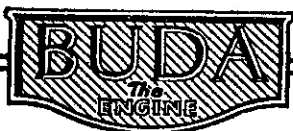


View of Scraping Main Bearings in Crankcase

Care should be taken that even pressure is applied to all parts of the ring, otherwise binding will follow. After the rings have been properly fitted to their grooves, try the pistons in their respective barrels and see that they move up and down freely. If there is any binding or tightness it is probably due to a tight ring or dirt in one of the ring gaps. This trouble should be rectified or a ring score in the cylinder will result.

into the cylinder and flat up against the piston bottom. The ring gap can now be checked with a feeler gauge.

Be sure the ring grooves in the pistons are clean, then slip the ring into place with the aid of a small skid as illustrated on page 39. These rings must be free in the grooves. If they are tight they should be removed, and the grooves inspected for any burrs. The rings may be smoothed by laying them on a flat piece of emery cloth on a surface plate or flat board and rubbing them.



Camshaft.

Install the camshaft in its proper place. If the bushings are to be installed, which should scarcely ever be necessary, they may be pressed into place, drilled and pinned like the old ones.

It is very hard to ream these properly without a line reaming fixture, so great care should be exercised to see that these bushings are reamed in line if a hand reamer is used. The camshaft should not be tight, and should slide into the bushings with little effort.

Cylinder Block.

Place the crankcase right side up and place a cylinder base gasket down over the studs. Use genuine BUDA gaskets in all places as they are of tough material, and graphited to prevent sticking and tearing when being removed. It is not necessary to shellac the cylinder base gasket as the studs hold it in place. Lower the block onto the studs and bolt down, drawing down evenly on the nuts.

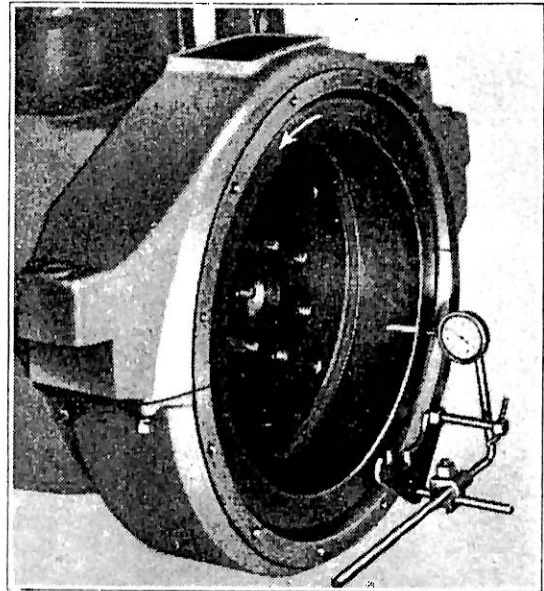
Main Bearings.

Main bearings should never be scraped while the flywheel is installed on the crankshaft. From the above discussion on shims and connecting rod bearings, there is little to be said, as to the scraping of main bearings, as most *good* mechanics have learned by experience the best method to follow.

The same precaution regarding fillets, shim tips, etc., should be carefully followed. The end play for the crankshaft is taken up in the center main bearings, and is held to 4 or 5 thousandths of an inch.

Check the clearance between the main journal flanges and the other two bearings. The rear bearing should have at least 25 thousandths of an inch clearance from the shaft flanges, and the rear end of the front should be the same. The distance between the crankshaft gear and the front end of the front main bearing should be no less than 6 thousandths of an inch when the shaft is pushed to the rear. The clearances are important as insurance against binding, due to expansion. In the case of new bearings, the shaft may be set up tighter than with old ones, but should never be set up so tight that it cannot be turned with the crank.

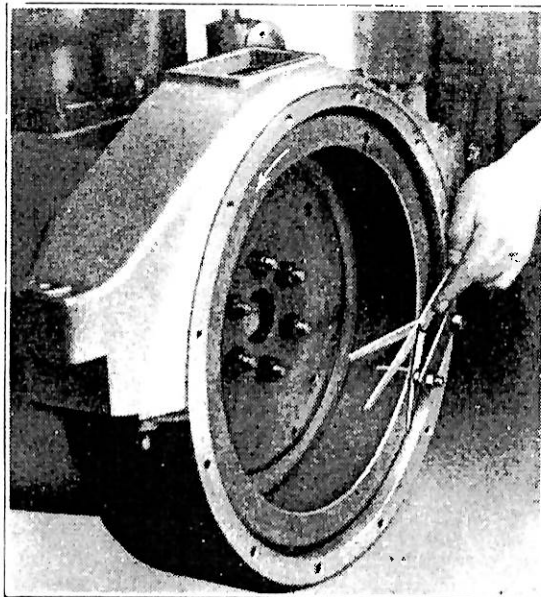
After finishing scraping the main bearings, see that oil holes in the crankshaft line up with the oil grooves in the main bearing. At the same time see that these oil grooves are of sufficient width and depth to supply the proper amount of oil to the connecting rods. These grooves should be approximately $\frac{3}{16}$ inch wide and $\frac{1}{16}$ inch deep. It is always best after scraping, to blow air through the oil line to remove the dirt or chips which have fallen through the holes in the bearings.



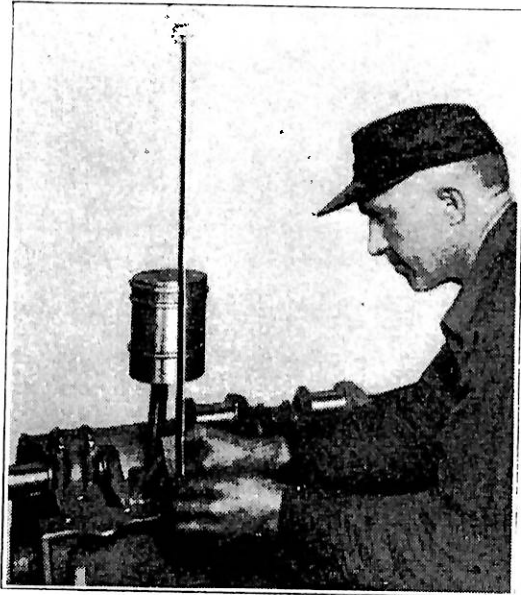
Indicating Flywheel with Dial Indicator

Flywheel.

In replacing the flywheel, it is important that no dirt or chips be allowed to remain in the crankshaft flange recess in the flywheel or the wheel will run out of true. Set the wheel on the flange and line up the holes. There is an odd or unevenly spaced hole, so the wheel can go on in just one position. Shove two bolts part way through the flange and wheel from the inside of the engine to act as guides. With two smaller bolts in diagonally opposite holes, pull the wheel into place on the crankshaft flange, by pulling evenly on these small bolts, watching all the time that the wheel is going on straight. When in place, drive in the two bolts which were



Indicating Flywheel with Feelers



Lining up Pistons with Steel Square at Side

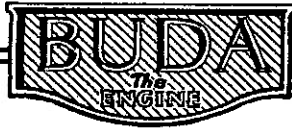
here illustrated two methods of checking. Page 57 shows the method of using a dial indicator. This may be clamped on the face of the flywheel housing with the point of the indicator placed against the face of the flywheel. The engine should be turned slowly and the high and low sides of the wheel noted. If the flywheel runs out more than eight thousandths, it should be removed and the crankshaft flange recess inspected for dirt or other foreign matter. Page 57 also shows a method which may be employed in case a dial indicator is not available. A bar may be clamped to the face of the flywheel housing and feelers inserted at different points as the engine is slowly rotated by using various thicknesses of feelers. The amount the flywheel runs out may be noted.



Lining up Pistons with Steel Square at End

first inserted as guides and also drive in two others. When the nuts are in place, the two small bolts may be removed and the remaining two flywheel bolts driven in and the nuts screwed on. Tighten the nuts very tight and insert cotter pins. If the wheel is not properly tightened, it will loosen up and make a noise resembling a loose rod or burned bearing.

If a flywheel runs out excessively, it indicates an out-of-balanced engine, and at the same time may cause clutch trouble. For this reason it is necessary that the flywheel be checked. We have



Lining Up Pistons.

Place the engine upside down on the floor and bolt one connecting rod with piston attached to the proper shaft journal. Be sure the rod is turned the right way, but let the piston and rod project up and not down into the cylinder. It will be noticed that the piston is reversed in this position and the cylinder number on the rod will be on the camshaft side. With the aid of a 12-inch steel square the piston sides should be checked for alignment as shown on page 58.

The square should be checked for accuracy by turning it around and comparing the inside and outside of it. The piston should be first placed in the position as shown in the upper illustration, the square placed on a flat bar of steel or straight edge extending across the crankcase or on one of the cross webs. The blade of the square should be at the center of the piston. When the piston is perfectly perpendicular with the crankcase, the square should be placed on the crankcase flange at the right angles to the first position, with the blade of the square passing up past the center of the wrist pin hole, or at the center line of the piston as shown in the lower illustration. If the square does not touch the piston from the third piston ring down as shown in the illustration, the rod should be gripped with a large monkey wrench at its center and bent until the piston lines up with the square.

Inserting the Pistons.

Make sure that crankshaft oil lines are free and open, then oil the cylinder walls, pistons and bearings. Space the piston ring gaps evenly around the pistons, then insert the pistons with the wrist pin set screw to the front or gear end with the cylinder numbers on the rods to the opposite side from the camshaft. The chamfer or bevel at the bottom of the cylinders should allow the rings to enter without any trouble. Replace the bearing caps so the number sides correspond with those on the rods making sure the shims are in place. Bolt the caps down, taking the strain evenly on the bolts. These bolts have two cotter pin holes. The lower ones, that is the ones farthest down the bolts, should be used if the nuts go down far enough. In tightening the nuts, never turn back the wrench in case a hole has been past, but tighten down to the next slot or use another nut if it is



too tight for this. In tightening the bolts if any are found to stretch they should be replaced.

Oil Pump.

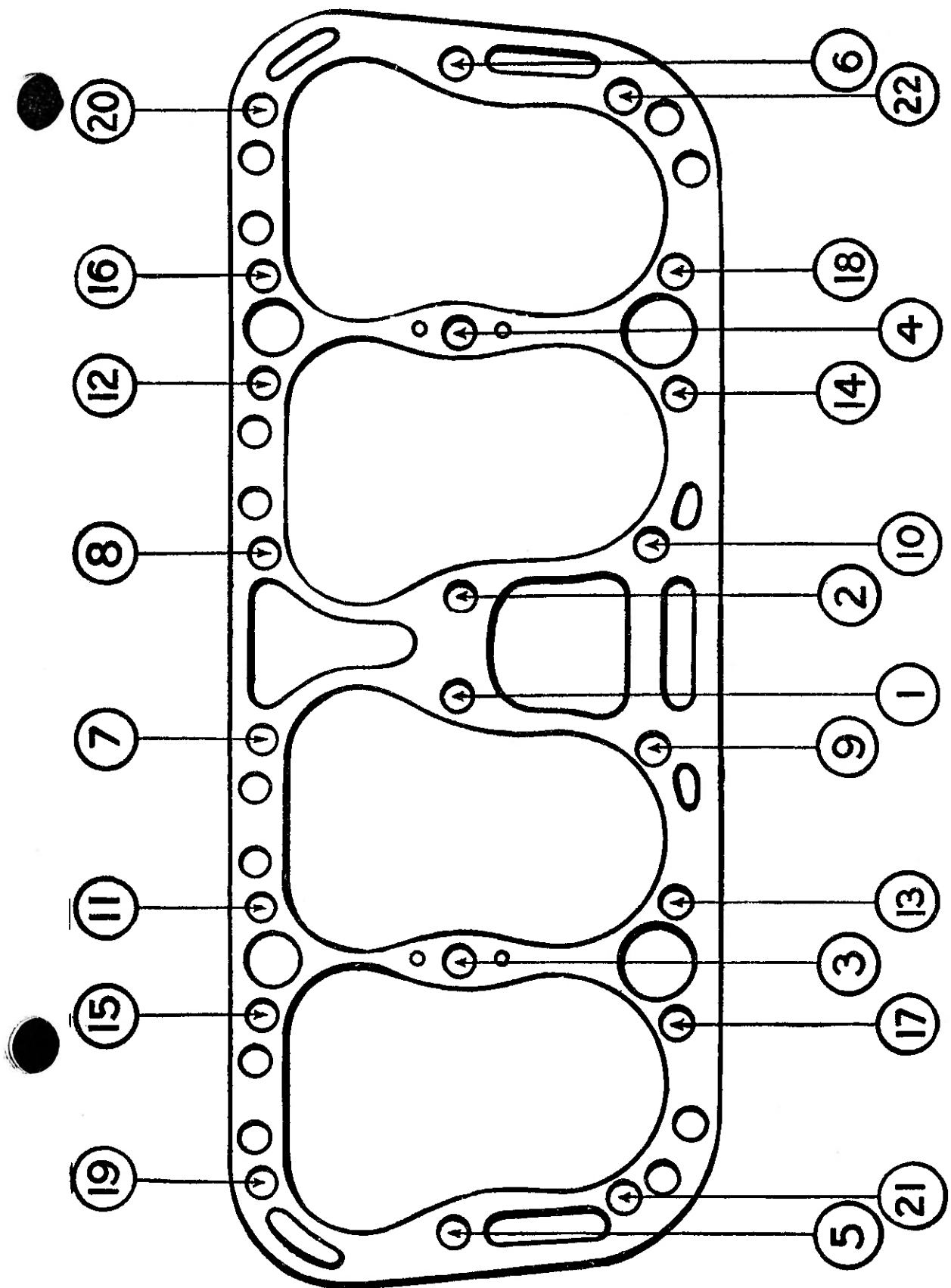
It is very seldom found necessary to remove the cover of the oil pump gears, but if this is removed, care must be taken to see that the gasket used on the plate is the same thickness as the gasket removed, otherwise there is excessive end play in the oil pump gears and oil will pass them, resulting in low oil pressure. Insert the driveshaft screws. Place the oil pump over the shaft and screw down, making sure the drive shaft enters the driveshaft slot. Revolve the crankshaft slowly and feel the pump driveshaft, making sure it is free and has a little back lash in each crank position.

The models MU and WTU have a different shaft arrangement than the others. The driveshaft is inserted from the outside of the engine and held in place by a cap with gasket which is situated behind the position of the carburetor. The assembling of the pump is the same and it should be lined up and checked for back lash the same as above.

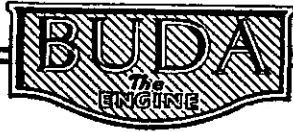
The HTU engine has the oil pump in the oil pan. The pump may be assembled, but should not be fastened into the pan until after the pan is fitted to the engine. The driveshaft is at the rear end. It also drives the governor and is inserted from the top of the crankcase. Care should be taken that the thrust washers of these pump shafts are in place before the shafts are inserted. A washer goes on each side of the gear.

Oil Pan.

A genuine BUDA graphited gasket should be shellacked to the crankcase. The lower half of the bell housing or flywheel cover may be fitted into place. Care must be taken to have the aluminum oil retainer come up against the rear main bearing cap as the lower half of the bell housing is put in place. If it does not, it should be removed and more gaskets placed under it. The dowel pins should be inserted before the cap screws are tightened down. Obtain a cork strip from a BUDA parts station and shellac to the lower half of the bell housing at the oil pan joint. If the *old* cork is in good condition and did not leak oil, it may be used again.



Cylinder Head Gasket Diagram Showing Where to Tighten First



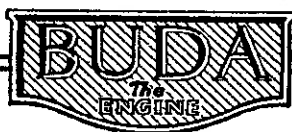
Lower the oil pan into place and bolt down evenly after locating the position with the dowel pins. *Do not shellac the oil pan gasket on both sides.* The graphited surface is to prevent sticking and tearing of the gasket when the pan is removed.

On the model HTU the gaskets should be shellacked to the oil pan only. After installing oil pan the pump and cover may be fastened in after first replacing oil screen and separator in their proper places.

Water Pump.

In case the bronze sleeve on the water pump shaft is badly worn by the pump packing, the whole shaft should be replaced. It is a difficult matter to keep a water pump from leaking if the bronze sleeves are badly worn. Remove the cover from the water pump and see that the rotor is tight on the shaft. Before leaving the water pump see that the holes for the passage of the grease are not stopped up with dirt. See that the grease actually finds its way to the packing. If the fan and water pump driveshaft bushings in the housing are worn so the shaft has a sloppy fit, to exceed .010 clearance, they should be renewed. This applies likewise to the bushing in the gear cover. These bushings are pinned into place with brass pins and care must be taken that the oil slots line up with the oil pockets and oil holes. These bushings should be reamed together when the housing and cover are in place, in order to get them perfectly in line. The housing and cover should be removed after reaming and all chips washed out. The water pump housing and shaft may then be assembled to the engine. See that fan and this shaft have at least four thousandths of an inch end play. If they have more, take the clearance up with brass washers placed over the shaft up against the gear.

Check the crank, idler and water pump gears for back lash. The gears should be set "no lash—no bind" which means that the lash should be none or very little, and yet no bind. The gears may be set by shifting the idler gear stud by loosening the three cap screws that hold it. It may be impossible, in the case of old gears, to remove all of the lash in this manner, but a little will not do any harm, as the gears have worn in and have a good bearing on the teeth. Do not attempt to replace a worn bushing and idler gear as the result will probably mean that the hole in the bushing will not be reamed true with the face of the gear.



Make sure the idler stud screws are very tight and the heads wired. Place the idler gear over the stud and thread in the left hand retaining nut. In case of a new gear, be sure it has a little end play on the stud when the brass nut is in place.

Checking Valve Timing—Refer to page 24.

Gear Cover.

The gear cover may now be fitted, after making sure all lock wires are in place. If the old graphited gasket is in good shape it may be used again. If a new one is used, it should be shellacked to the cover only, and not to the case. The dowel pins will locate the exact position of the cover. When in place, tighten up with the cap screws and bolts, pulling up evenly on them. The oil thrower collar should be slipped over the fan pulley shaft before the pulley or woodruff key is put in place. Make sure this oil thrower is on the right way. The large end should face the front of the engine, that is, out.

Cylinder Head.

With the engine upright, remove the cylinder head which was temporarily fitted before the block was installed, and clean the gasket surface of the block and head, making sure the cylinders and piston tops are clean. Slip the old gasket down over the studs after making sure it is not dented at any place, or damaged in any other way. Use no shellac on the gasket, but a little cup grease may be smeared on the sides of the gasket if desired. Shake the cylinder head around, making sure there is no loose dirt in the water jackets to drop onto the gasket, then lower the head down over the studs. Great care should be taken in tightening down the head, but before a nut or washer is put in place, the spark plug and priming cock holes must be plugged with corks or plugs to prevent any material from getting down into the cylinders.

The following diagram and description will show the proper method of tightening down the cylinder head, see page 61.

The center row should be tightened down quite tight, first starting from the nuts between the second and third cylinders, and working toward the front and back alternately. The outside rows should then



be tightened a little, by alternating from one side to the other and working alternately from the middle of the block toward each end. In this way the gasket gets worked out towards the sides as it is compressed and is then compressed evenly. When all of the nuts have been tightened a little as mentioned above, they should be gone over again in the same manner, until they are properly tight. A little judgment will have to be used by the person doing the work, as to when the head is tight. This depends upon how long the wrench handle is and the strength of the person using it. If too much strain is used, the nuts will strip on the studs.

When the engine has warmed up on its first run after the head has been fitted, the nuts should be pulled down again, or oil will seep through the gasket.

Mounting the Engine.

The engine is now ready for the chassis and may be placed into it in the same manner as it was removed. The electrical equipment may be placed on the engine before or after it is installed. The setting of the ignition is taken up under the heading "IGNITION." The fan pulley and fan should be fitted before the radiator is replaced.

PISTON DISPLACEMENTS

S T R O K E S

CUBIC INCHES

4 CYL. ENGINES

| BORE | 4 | 4 1/8 | 4 1/4 | 4 3/8 | 4 1/2 | 4 5/8 | 4 3/4 | 4 7/8 | 5 | 5 1/8 | 5 1/4 | 5 3/8 | 5 1/2 | 5 5/8 | 5 3/4 | 5 7/8 | 6 | 6 1/8 | 6 1/4 | 6 3/8 | 6 1/2 |
|---------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 3 1/2 | 153.9 | 158.7 | 163.5 | 168.4 | 173.2 | 178.0 | 182.8 | 187.6 | 192.4 | 197.2 | 202.0 | 206.8 | 211.6 | 216.5 | 221.3 | 226.1 | 230.9 | 235.7 | 240.5 | 245.3 | 250.1 |
| 3 5/8 | 159.5 | 164.4 | 169.4 | 174.4 | 179.4 | 184.4 | 189.4 | 194.3 | 199.3 | 204.3 | 209.3 | 214.3 | 219.3 | 224.3 | 229.2 | 234.2 | 239.2 | 244.2 | 249.2 | 254.2 | 259.2 |
| 3 7/8 | 165.1 | 170.3 | 175.5 | 180.6 | 185.8 | 190.9 | 195.3 | 201.3 | 206.4 | 211.6 | 216.7 | 221.9 | 227.1 | 232.2 | 237.4 | 242.5 | 247.7 | 252.9 | 258.0 | 263.2 | 268.3 |
| 3 1 1/8 | 170.9 | 176.2 | 181.5 | 186.9 | 192.2 | 197.6 | 202.9 | 208.2 | 213.6 | 218.9 | 224.3 | 229.6 | 234.9 | 240.3 | 245.6 | 251.0 | 256.3 | 261.6 | 267.0 | 272.3 | 277.7 |
| 3 1 1/4 | 176.7 | 182.2 | 187.7 | 193.3 | 198.8 | 204.3 | 209.9 | 215.4 | 220.9 | 226.4 | 231.9 | 237.4 | 242.9 | 248.5 | 254.0 | 259.5 | 265.0 | 270.5 | 276.1 | 281.6 | 287.1 |
| 3 1 1/2 | 182.7 | 188.4 | 194.1 | 199.8 | 205.5 | 210.7 | 216.9 | 225.6 | 228.3 | 234.0 | 239.7 | 245.4 | 251.2 | 256.9 | 262.6 | 268.3 | 274.0 | 279.7 | 285.4 | 291.1 | 296.8 |
| 3 1 3/8 | 188.7 | 194.6 | 200.4 | 206.4 | 212.3 | 218.2 | 224.0 | 229.9 | 235.8 | 241.7 | 247.6 | 253.5 | 259.4 | 265.3 | 271.2 | 277.1 | 283.0 | 288.9 | 294.8 | 300.7 | 306.6 |
| 3 1 1/2 | 194.8 | 200.9 | 207.0 | 213.1 | 219.2 | 225.3 | 231.3 | 237.4 | 243.5 | 249.6 | 256.7 | 261.8 | 267.9 | 274.0 | 280.0 | 286.1 | 292.2 | 298.3 | 304.4 | 310.5 | 316.6 |
| 4" | 201.1 | 207.4 | 213.6 | 219.9 | 226.2 | 232.5 | 238.8 | 245.0 | 251.3 | 257.6 | 263.9 | 270.2 | 276.5 | 282.8 | 289.0 | 295.3 | 301.6 | 307.9 | 314.4 | 320.5 | 326.7 |
| 4 1/8 | 207.4 | 213.9 | 220.3 | 226.8 | 233.3 | 239.8 | 246.3 | 252.8 | 259.2 | 265.7 | 272.2 | 278.7 | 285.2 | 291.8 | 298.1 | 304.6 | 311.1 | 317.8 | 324.1 | 330.5 | 337.0 |
| 4 1/4 | 213.8 | 220.5 | 227.2 | 233.9 | 240.5 | 247.2 | 253.9 | 260.6 | 267.3 | 274.0 | 280.6 | 287.3 | 294.0 | 300.7 | 307.4 | 314.0 | 320.7 | 327.4 | 334.1 | 340.8 | 347.5 |
| 4 1/2 | 220.4 | 227.2 | 234.2 | 241.0 | 247.9 | 254.8 | 261.7 | 268.6 | 275.4 | 282.3 | 289.2 | 296.1 | 303.0 | 309.9 | 316.7 | 323.6 | 330.5 | 337.3 | 344.2 | 351.1 | 358.0 |
| 4 3/4 | 226.9 | 234.0 | 241.1 | 248.2 | 255.3 | 262.3 | 269.4 | 276.5 | 283.6 | 290.7 | 297.8 | 304.9 | 312.0 | 319.1 | 326.3 | 333.4 | 340.5 | 347.5 | 354.6 | 361.7 | 368.8 |
| 4 1 1/8 | 233.7 | 241.0 | 248.3 | 255.6 | 262.9 | 270.2 | 277.5 | 284.8 | 292.1 | 299.4 | 306.7 | 314.0 | 321.3 | 328.6 | 335.9 | 343.2 | 350.5 | 357.8 | 365.1 | 372.4 | 379.7 |
| 4 1 1/4 | 240.5 | 248.0 | 255.5 | 263.1 | 270.6 | 278.1 | 285.6 | 293.1 | 300.7 | 308.2 | 315.7 | 323.2 | 330.7 | 338.2 | 345.8 | 353.3 | 360.8 | 368.3 | 375.8 | 383.3 | 390.9 |
| 4 1 1/2 | 247.5 | 255.2 | 262.9 | 270.7 | 278.4 | 286.1 | 293.8 | 301.6 | 309.3 | 317.1 | 324.8 | 332.5 | 340.2 | 348.0 | 355.7 | 363.4 | 371.2 | 378.9 | 386.7 | 394.4 | 402.1 |
| 4 1 3/8 | 254.5 | 262.4 | 270.4 | 278.3 | 286.3 | 294.2 | 302.2 | 310.2 | 318.1 | 326.1 | 334.0 | 341.9 | 349.9 | 357.8 | 365.8 | 373.7 | 381.7 | 389.6 | 397.6 | 405.5 | 413.5 |
| 4 1 1/2 | 261.6 | 269.8 | 278.0 | 286.1 | 294.3 | 302.5 | 310.7 | 318.8 | 327.0 | 335.2 | 343.4 | 351.5 | 359.7 | 367.9 | 376.0 | 384.2 | 392.4 | 400.5 | 408.7 | 416.9 | 425.1 |
| 4 1 3/4 | 268.8 | 277.2 | 285.6 | 294.0 | 302.4 | 310.8 | 319.2 | 327.6 | 336.0 | 344.4 | 352.8 | 361.2 | 369.6 | 378.0 | 386.4 | 394.8 | 403.2 | 411.6 | 420.0 | 428.4 | 436.8 |
| 4 1 1/2 | 276.1 | 284.7 | 293.4 | 302.0 | 310.6 | 319.2 | 327.9 | 336.5 | 345.1 | 353.8 | 362.4 | 371.0 | 379.6 | 388.3 | 396.9 | 405.5 | 414.2 | 422.8 | 431.4 | 440.1 | 448.7 |
| 4 3/4 | 283.5 | 292.4 | 301.2 | 310.1 | 319.0 | 327.8 | 336.7 | 345.6 | 354.4 | 363.3 | 372.1 | 381.0 | 389.9 | 398.7 | 407.6 | 416.4 | 425.3 | 434.1 | 443.0 | 451.9 | 460.7 |
| 4 1 1/2 | 291.1 | 300.1 | 309.2 | 318.3 | 327.4 | 336.5 | 345.6 | 354.7 | 363.8 | 372.9 | 382.0 | 391.1 | 400.2 | 409.3 | 418.4 | 427.5 | 436.6 | 445.6 | 454.7 | 463.8 | 472.9 |
| 4 3/4 | 298.6 | 308.0 | 317.3 | 326.6 | 336.0 | 345.3 | 354.6 | 364.0 | 373.3 | 382.6 | 392.0 | 401.3 | 410.6 | 420.0 | 429.3 | 438.8 | 448.0 | 457.3 | 466.6 | 476.0 | 485.3 |
| 4 1 1/2 | 306.3 | 315.9 | 325.5 | 335.1 | 344.6 | 354.2 | 363.8 | 373.4 | 382.9 | 392.5 | 402.1 | 411.6 | 421.2 | 430.8 | 440.4 | 449.9 | 459.5 | 469.1 | 478.7 | 488.2 | 497.8 |
| 5" | 314.1 | 324.0 | 333.8 | 343.6 | 353.4 | 363.2 | 373.0 | 382.9 | 392.7 | 402.5 | 412.3 | 422.1 | 431.9 | 441.8 | 451.6 | 461.4 | 471.2 | 481.0 | 490.8 | 500.6 | 510.5 |



THE BUDA COMPANY

SERVICE WARRANTIES AND POLICIES

The Buda Company has adopted the following as its Service Warranties and Policies:

1. STANDARD SERVICE WARRANTIES:

(a) Subject to the provisions of paragraphs "b" to "f" inclusive The Buda Company guarantees its products against defective materials or workmanship as follows:

| | |
|---|--|
| Off highway, Rail Car and Locomotive Equipment. | Six months from date of shipment but not to exceed ninety days or 15,000 miles of service. |
| Highway Diesel Truck and Bus Engines | 100,000 Miles, or one year from date of shipment, whichever shall first occur. |
| Jacks and Railroad Equipment | Six months from date of shipment. |
| Agricultural, Industrial, Oil Field, Marine, Electric Generator and Shop Truck Equipment, etc., other than as listed below: | Six months from date of shipment but not to exceed ninety days of service. |
| Marine pleasure craft propulsion, Marine emergency and standby, and Fire Fighting equipment. | One year from date of shipment. |

Provided, however, that the guarantee of The Buda Company on materials or equipment which are purchased from an outside source shall be limited to the guarantee of the outside manufacturer to The Buda Company.

(b) Parts returned, transportation charges prepaid, at Purchaser's risk and with permission of The Buda Company, which are found by The Buda Company to be defective in material or workmanship, shall, at the option of The Buda Company, either be repaired, replaced or credited, and it is agreed that the liability of The Buda Company is expressly limited to such repairing, replacement or credit. Any warranty is void unless Purchaser provides proper care and storage of units or parts from date of shipment to date placed in service. No claims will be allowed which in the opinion of The Buda Company result from units or parts having been subjected to abuse or neglect or where failure has been caused by accident.

(c) The Buda Company shall not be liable for any personal injury or property damage of any nature, nor for any expense incurred for materials furnished or work done by or for the Purchaser or its customers or users of products of The Buda Company in connection with or due to any alleged defects unless previously authorized by The Buda Company in writing.

(d) The Buda Company assumes no responsibility for contingent liability through the failure of any product or part therefor.

(e) If The Buda Company renders service on an allegedly defective product of its manufacture and the said product is found not to be faulty the time and expense chargeable to such service shall be charged to and paid by the person or firm who requested such work to be done.

(f) The following information must be submitted with all requests for adjustments covering field service and alleged defects:

1. Owners name and address.
2. Description and model number.
3. Serial number (if any).
4. Type of service.
5. Information as to the nature of the trouble.
6. Date actually placed in service.
7. Accumulated days or miles of service.
8. Make and model of associated equipment if used with other machinery.

2. FIELD SERVICE:

A. Engine Division

(a) Field service facilities are maintained by (a) distributors and (b) by manufacturers using Buda engine products in equipment manufactured by them. All requests for field service must be handled through the distributor or manufacturer who sold the equipment and any requests received direct from sub-distributors, dealers or users will be referred to the appropriate party.

B. Railroad and Industrial Division (except Earth Drills, Industrial Tractors and Trucks).

(a) The Railroad and Industrial Division of The Buda Company maintains factory field service facilities for the benefit of railroads and industrial users of Buda railway and industrial equipment which facilities can be provided upon written request to the factory.

C. Earth Drills and Industrial Tractors and Trucks.

(a) Field service facilities for equipment purchased direct from The Buda Company by Class "A" railroads are available and can be provided as outlined in paragraph "B" (a) above.

(b) Field service facilities for equipment purchased by users other than Class "A" railroads are usually maintained by the distributors of these products in their respective territories and requests for such service received direct from such territories will be referred to the appropriate distributor.

3. General:

(a) The Buda Company reserves the right to improve its products through changes in design or materials without being obligated to incorporate such changes in products of prior manufacture.

(b) No distributor, dealer or agent is authorized to transact any business in the name of nor to incur any liabilities or obligations on behalf of The Buda Company unless specifically so authorized in writing by an official of The Buda Company.