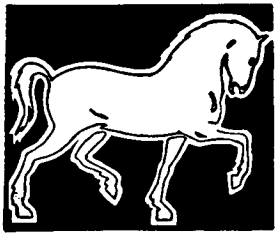
GENERAL INSTRUCTIONS

FOR THE CARE AND OPERATION OF

WAUKESHA .. ENGINES ..

WAUKESHA MOTOR COMPANY

WAUKESHA  **WIS.**

EDITION 9
FORM 1131-F

PRICE 25 CENTS

LUBRICATION RECOMMENDATIONS

Because Waukesha engines are in service all over the world, this company does not attempt to recommend either by name or brand all the lubricating oils which are suitable for use. The viscosity or body of the oil is the only property specified in the lubrication recommendations. Quality—life, heat-resistance, acid forming, and sludging tendencies as well as other commonly specified physical properties—should be the supplier's responsibility. The principle factors in selecting the proper grade of oil for an engine are: 1—Operating temperature of the oil in the crankcase and 2—"Engine Class" which is dependent upon the size, bearing clearances, and speed at which the engine operates.

Two methods of making this selection are suggested in the following paragraphs and tables which accompany them. Method one is most exact, and should be followed unless the use of an oil temperature gauge is not practicable. It is the only positive and accurate method of selecting a suitable oil, because it takes into account the exact temperature of the oil under all conditions of load and service by a thermometer immersed in the oil sump, and it is this temperature which determines the actual operating viscosity of the oil itself. It should always be used wherever it is practical to install an oil temperature indicator. The second is an approximate method basing the selection upon existing temperatures of the air surrounding the engine instead of the actual operating temperature of the crankcase oil.

HOW TO SELECT THE PROPER OIL

Oil Temperature Method

First turn to the inside back cover, and from the model of your engine determine its classification, the quantity of oil required, and the normal oil pressure. It will fall under one of the three classifications, A, B, or C. Observe the maximum temperature of the oil in the crankcase when the engine is in actual operation and then refer to the left-hand column of Table I. Find the temperature range that includes the reading you have just taken, and follow this line across the table to the column for your class engine (A, B, or C) as given in the table on the inside back cover. Use an oil of the viscosity indicated. If the engine is used in different kinds of service from time to time, it is advisable to re-check the oil temperature and revise your selection with each change because oil temperatures will vary according to the severity of the service and changes in the surrounding air temperatures.

Minimum Viscosity: The tabulation is arranged on the basis of providing a constant minimum viscosity for each class of engine throughout the oil operating temperature range. The ***minimum*** Standard Saybolt viscosities are 54, 62, and 72 for Engine Classes A, B, and C respectively.

Maximum Crankcase Oil Temperature: The "Oil Operating Temperature" range in Table I is not carried above 220° since most present day engines and lubricants stand up best if this top limit is not exceeded. Oil coolers should be provided if operating conditions tend to produce temperatures in the oil sump that are higher than this.

Minimum Crankcase Oil Temperature: The oil operating temperature range is not carried below 140° because crankcase condensation, sludging and corrosion become excessive at temperatures below 140° while the reduced efficiency of many oil filters at temperatures lower than this renders them practically useless. Shutters, thermostats, and any other means required should be applied when operating conditions will not maintain proper oil temperatures without them.

TABLE I

OIL OPERATING TEMPERATURE	S.A.E. VISCOSITY NUMBERS		
	Class "A" Engine	Class "B" Engine	Class "C" Engine
200–220° F.	30	40	50
180–200° F.	20/20W	30	40
160–180° F.	10W	20/20W	30
140–160° F.	10W*	10W	20W

*Ten per cent kerosene can be added to oil if necessary to provide satisfactory cold weather starting.

Air Temperature Method

The "Air Temperature Method" is the conventional and familiar way of specifying oils which give approximate results, but because there may be circumstances under which it is impossible to obtain actual oil sump temperatures it is repeated here for convenience of users. In this case, turn to the inside back cover for the table which classifies the engine and then follow the directions given in Table II. "Heavy Duty" is considered a continuous pull ranging from one-half to full load, while "light duty" is considered as any service, no matter if it be continuous, that does not exceed, except for brief intervals, one-half the maximum power of the engine.

No fixed rule can be applied to determine every possible service classification, but when the service is a border-line case as often occurs in portable compressor duty, the operator should watch the oil closely to see that it is not too light to maintain its lubricating properties and the specified oil pressure.

COLD WEATHER STARTING

Following the oil temperature chart recommendations will give you the lightest grade of oil that it is practical to use at all times and even for winter operating conditions. In some cases, even these oils when chilled by standing overnight in sub-freezing temperatures may not permit easy starting. Under such conditions a lighter oil is permissible, but since the lighter oils may over-heat after the engine gets under load, an oil cooler must be added to prevent this. With engines operated outdoors in severe winter weather, it is often advisable to drain the oil from the engine each night and keep it warm indoors until the next starting time. Do not place it near an open flame or stove. It might start an explosion.

TABLE II

TEMPERATURE OF SURROUNDING AIR	S.A.E. VISCOSITY NUMBERS					
	Class "A" Engine		Class "B" Engine		Class "C" Engine	
	Light Duty	Heavy Duty	Light Duty	Heavy Duty	Light Duty	Heavy Duty
70–90° F.	20/20W	30	30	40	40	50
50–70° F.	20/20W	20/20W	20/20W	30	30	40
30–50° F.	10W	10W	10W	20/20W	20/20W	30
Below 30° F.	10W*	10W*	10W*	10W	10W	20W

*Ten per cent kerosene can be added to oil if necessary to provide satisfactory starting.

GENERAL INSTRUCTIONS

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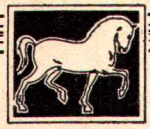

EDITION 9
FORM 1131-F

WAUKESHA MOTOR COMPANY
WAUKESHA, WISCONSIN

PARTS & SERVICE DEPOTS:
New York City: 33 West 60th Street
Tulsa, Oklahoma: 703 S. Wheeling
Los Angeles, Calif.: 4927 Pacific Blvd.

NEW YORK OFFICE:
8 West 40th Street
New York 18, N.Y.

MID-CONTINENT WAREHOUSE:
703 S. Wheeling
Tulsa, 4, Oklahoma

LOS ANGELES OFFICE
4927 Pacific Blvd.
Los Angeles 11, Calif.

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STANDARD WARRANTY

The Waukesha Motor Company is a member of the Internal Combustion Engine Institute. The Service Warranty and policies adopted by the Internal Combustion Engine Institute are as follows:

1—Standard Service Warranties

a. The members of this industry shall guarantee their engines and parts thereof against defective material or workmanship as prescribed in paragraph 1-(b).

b. Type of Application	*Warranty Period*
Bus and Truck Equipment	Six months from date of shipment but not to exceed ninety days or 15,000 miles of service.
Rail Cars and Locomotives	Six months from date of shipment but not to exceed ninety days or 15,000 miles of service.
Agricultural Equipment	Six months from date of shipment but not to exceed ninety days of service.
Industrial Equipment	Six months from date of shipment but not to exceed ninety days of service.
Marine Equipment	One year from date of shipment.
Fire Equipment	One year from date of shipment.

c. Parts returned to any member of the industry, transportation charges prepaid, which are found by the member to be defective in material or workmanship, shall at the member's option be repaired, replaced, or credited. No claims will be allowed which, in the opinion of the member, result from engines or parts having been subjected to abuse or neglect or where failure has been caused by accident.

d. Warranty on accessories furnished by each member shall be limited to the warranty of the accessory manufacturer.

e. Any warranty is void unless the Buyer or his agents provide proper care and storage of engines and parts from date of shipment to date placed in service.

f. Each member reserves the right to improve his product through changes in design or materials without being obligated to incorporate such changes in engines of prior manufacture.

g. No responsibility for contingent liability through the failure of any engine or engine part will be assumed by a member of this industry.

2—Field Service—THE TERM BUYER, AS USED HEREIN, MEANS A CUSTOMER OF A MEMBER OF THIS INSTITUTE.

a. The responsibility of maintaining or arranging for adequate and proper field service facilities shall be with the Buyer, and he shall not request the assistance of any member of this industry except in cases of a complex character.

b. All requests for service in the field shall emanate from the Buyer of the engines. Requests received from a Buyer's dealer or the ultimate user shall, under normal conditions, be referred to the Buyer.

c. If a member renders field service at the request of the Buyer and the fault is found not to be with the engine, the Buyer shall pay the time and expense of the member's field representative.

d. No member shall accept bills for service, labor or other expense that he has not previously approved and authorized.

e. Before consideration can be given to requests for adjustments covering field service and alleged defective material, the Buyer shall furnish the member with the following data:

Owner's name and address

Engine model

Serial number

Information as to nature of trouble

Date actually placed in service

Accumulated days or miles of service

3—The Return of New Material—

a. Any member of this industry may at his option accept the return of any part or parts provided such return has been authorized, and at prices agreed upon, transportation charges prepaid. Such authorized returns shall be subject to the member's inspection and to a handling charge of ten per cent, 10%, of the cost of the part or parts returned.

4—Labor and Other Expenses—

a. No member of this industry shall assume any expense except direct labor in replacing parts or servicing engines within the warranty period, and in no case shall such expense be assumed unless authorized by the member.

CAUTION

Protective devices such as ***governors*** to control the engine speed, ***air cleaners, oil filters*** and similar fixtures to ***prolong engine life,*** are provided for the mutual protection of the owner and the Company. Failure to maintain them in operative condition or to replace them when they become inoperative will result in greatly decreased durability.

INTRODUCTION

1—This book is not a service manual but a simple outline of duties that the owner and operator must perform to insure satisfactory service.

*2—**For the mechanic*** who requires more specific advice, full information will be sent upon receipt of detailed request directed to our Service Department. Be sure to give the engine model and serial number taken from the name plate.

*3—**Tabulated Data***—The important facts about all Waukesha Gas and Gasoline Engines have been conveniently arranged in the pages of Tabulated Data on the separate insert furnished with this book. The Table gives the model, size, oil specifications, water capacity of industrial units for proper proportioning of anti-freeze solutions, safe operating speeds, tappet settings for adjusting valves after grinding, the maximum spark advance for limiting the range of the advance mechanism, and important clearance dimensions.

*4—**Using the Tabulated Data—When this book is first received,*** it is recommended that ***the engine be promptly identified*** from the name plate markings; that they be ***recorded*** in the ***"Engine Record"*** at right, and that a heavy pencil line be run around the column in the Data that is headed by the model number found on the engine name plate. This will save time later when referring to the Data Table, and insure accuracy when ordering license plates, reporting loss, placing insurance, ordering parts, or corresponding with the Company regarding questions pertaining to the engine.

ENGINE RECORD

MODEL

NO. DATE

GOVERNED SPEED

PART 1

STARTING A NEW ENGINE

*5—**Inspection***—Before starting a new engine, inspect it thoroughly, and see that it is complete and in proper working order. Make sure that the following preparations are made in the order named.

*6—**Proper Lubrication***—The most important precaution with ***any*** engine is to see that it has ***plenty*** of ***good oil*** at all times. Refer to the special instructions printed on the inside front and back covers of this book and select the proper oil for your engine. If the "Oil Temperature Method" is used without any previous experience to guide you, start off with an oil of the average viscosity for your Engine Class, and by observing its maximum temperature after it is under load, you can make your future selections with exact knowledge. The "Surrounding Air Temperature Method" may similarly be used for the initial trial period to obtain oil temperature data for future guidance. Some engines are equipped with copper lead or cadmium silver bearings. It is, therefore, urged that whatever oil you select should be one which the supplier will guarantee does not attack these alloys.

*9—**Proper Fuel***—All Waukesha Engines have been designed to utilize smoothly and economically whatever fuel is most commonly used in the field of service in which the engine is placed. Use the cleanest fuel obtainable and keep the fuel line free from sand, lint or water. A fuel filter is a good investment.

*10 — **Air Cleaners*** — An efficient ***air cleaner*** for both the ***carburetor*** and the ***breather*** is ***essential*** to long engine life and ***its omission*** may be regarded as possible ***grounds for voiding our guarantee.***

To insure efficient operation, all pipes, tubing and passages should be tightly taped so that

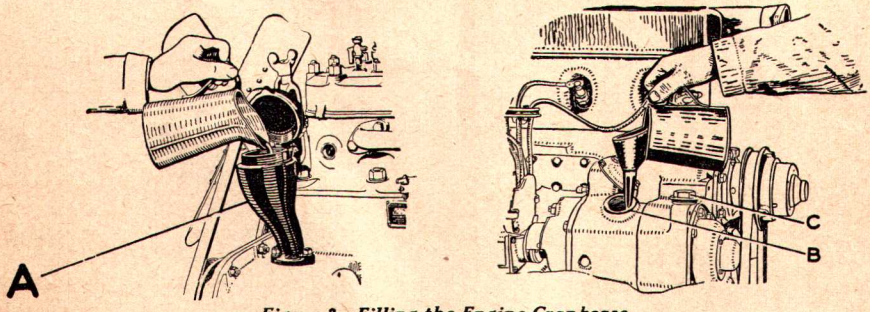


Figure 2—Filling the Engine Crankcase
A—Combined filler and breather. B—Filler opening of valve-in-head engines is always not combined with breather but closed by screw plug, C.

*7—**Proper Cooling***—Next to proper oiling, cooling an engine is most important. Be sure that the cooling system is full; that it does not leak; and that none of the hose connections have collapsed or become obstructed.

*8—**Cooling Water***—Whenever possible avoid hard or alkaline waters and use soft or distilled water in the cooling system. If alkaline waters must be used, a treatment with "Scalina," "Quick Solvent," or some other softening compound will reduce the scaling and prevent clogging of the water jackets and radiator. When over-heating occurs due to scale it should be removed by following the method for cleaning detailed in paragraph 320.

all the air entering the engine ***must*** pass through the cleaner. ***Keep the cleaner clean*** and in full working order. A fouled carburetor air cleaner cuts the engine's power and will shorten the engine life. A clogged breather induces oil-pumping and leaks.

*11—**Safe Engine Speeds—Over-speeding*** has ***ruined*** more ***engines*** than hard work. ***Over-speeding*** may ***void our guarantee.*** All four and six-cylinder industrial units are equipped with governors which

maintain the speed within the proper limits as shown in the Tabulated Data. Under no conditions should maximum permissible speeds be exceeded. Some duties, however, have lower speed requirements; and if the equipment manufacturer recommends lower speeds than given in this book, be sure to follow his instructions.

12—Special Precaution with New Engines—

a. ***Put Lubricating Oil in Fuel Tank***—Use about one pint of light cylinder oil to every three to five gallons of fuel during the first 50 hours of service.

b. Fill and screw down all the grease cups.

c. See that the fan hub is filled with oil.

d. Remove the spark plugs and squirt a teaspoonful of light cylinder oil in each cylinder to insure lubrication of the pistons and cylinders when the engine first starts.

e. Idle the engine about fifteen minutes to fill all the bearings with oil.

. Stop any water leaks after the engine gets hot under load.

g. Tighten all cylinder head nuts after the engine is hot. ***Be sure to read paragraph 616 before doing this.***

13—General Starting Procedure—

a. ***Check Oil Supply***—Remove the bayonet oil gauge and fill the crankcase until the gauge shows ***full.*** Consult the Lubrication Data on the inside back cover of this book for the quantity required if the engine is empty.

b. ***Water***—See that the cooling system is full of water.

c. ***Fuel***—Be sure that there is fuel in the tank.

d. ***Throttle Setting***—Set the throttle lever about one-quarter open. (This may vary with different makes of carburetors. See the carburetor manual for specific advice.)

e. ***Spark Advance Setting***—If a magneto is used, the spark lever ***must be*** slightly advanced. With a ***battery*** ignition it ***must be retarded*** at starting.

f. ***Ignition Switch***—Set the switch to "ON" position. If engine is equipped with automatic safety switch operating on low oil pressure or high water temperature, be sure it is set in running position.

g. ***Close Choke Valve***—The carburetor choke valve is usually operated by a pull wire and restricts the air supply. ***The engine should not be run with the choke closed.*** Open it as soon as the engine will run with the choke open. When starting an engine that is hot, do not use the choke, as it will make starting difficult.

h. ***Engine Is Ready to Start***—If it has no power starter, engage the starting crank and PULL UP. Do not grasp the starting crank between the thumb and fingers; keep the thumb on the same side as the fingers to avoid a broken wrist, should the engine kick. An engine should start with the third or fourth pull-up of the starting crank.

i. ***Open Choke as Soon as Possible After Starting***—To start easily in cold weather close the choke, leave the ignition "off," crank four or five cylinders full of mixture, then open the choke, turn "on" the ignition and crank.

j. ***Test Oil Pressure***—The oil pressure may not build up at once, especially in cold weather, so a few moments of idling will be necessary to fill the lines and build up the pressure before the engine is ready to put under load. After sufficient idling time has elapsed, check the pressure by an oil gauge applied to the threaded opening entering the oil line or by putting a petcock in the same place, and opening it while the engine is running. The same test can also be made by removing the pipe plug when the engine is running, but this is recommended only as an emergency. An oil pressure gauge may be obtained from us at small cost. ***Oil pressure should be up to the specification shown in Lubrication Data on the inside back cover of this book.***

PART II

LUBRICATION

THE OILING SYSTEM

100—General—Waukesha engines do not require "trick" oils; paragraph 6 and the table on the inside front cover explain this. Full pressure lubrication which distributes oil through positive channels to all of the principal bearings and wearing surfaces is used on all models. It is entirely automatic and keeps the oil circulating positively in these ducts as long as the engine is in operation and the oil supply is maintained. When the engine stops, the surplus oil on the internal parts drains back to the main reservoir in the bottom of the engine. The proper operation of this oiling system is usually shown by an oil pressure gauge. (See paragraph 13-j.)

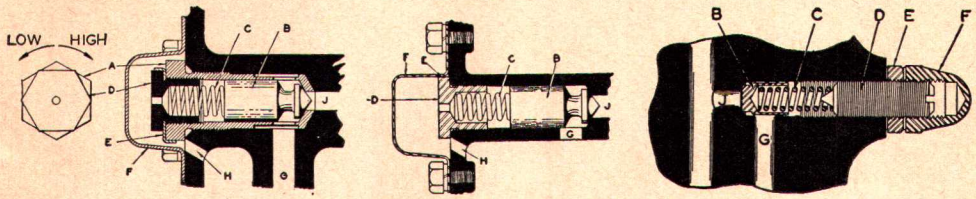


Figure 3—Oil Relief Valves of the Three Standard Types

A—Steel shell valve body screwed into aluminum crankcase. B—Cylindrical valve plunger. C—Pressure control spring. D—Pressure adjusting screw. E—Adjusting screw lock. F—Protecting cap. G, H—Passages for overflow to crankcase when valve, B, opens. J—Oil pressure duct from main oil line.

101—Oil Pressure—The proper oil pressure for each engine under load is listed in the Lubrication Data on the inside back cover of this book. In cold weather this pressure may not develop immediately because it takes a little time for the thick oil to flow freely. (See paragraph 13-j.) At low idling speeds, these pressures will be much lower. On small engines, they may drop to five pounds with a corresponding drop in larger engines. The pressure is controlled by an automatic spring loaded relief valve built into the side of the crankcase. If the pressure drops to zero suddenly or fluctuates violently while the engine is under load, stop the engine, and investigate. If the bayonet oil gauge shows the oil supply is adequate, it may be that it has been used too long and has become thinned by dilution. The obvious remedy is to drain the crankcase, and replace the old oil with new oil of the proper grade. If this does not correct the trouble, it is possible that dirt has lodged under the relief valve or an oil line is ruptured. In either case, the cause should be removed before starting the engine.

102—Oil Changing—With one exception (see paragraph 702) all the oil is carried in the bottom of the crankcase. The quantity required to fill each engine is indicated in the Lubrication Data on the inside back cover of this book. With an engine that is in daily use, the oil level should be inspected before starting each morning. A bayonet gauge is located on the same side as the filler opening. The ***oil*** supply should be held at full level and a complete ***change*** should be made at least ***every 50 hours*** with a ***new engine,*** and ***after*** the first ***two hundred hours of service*** the oil should be changed ***at least*** every 100 hours of operation. ***GAS ENGINES*** will require more frequent changes because the absence of dilution makes the oil grow heavy and tends to clog filters and lines more quickly. This is the maximum life that should be expected from a single change of oil. Not all oils in every type of engine will give maximum service. It is therefore recommended that the oil be carefully examined after the first draining to determine whether the particular brand is standing up in service. If it has broken down, and has been badly thinned out or become thick and sludgy, it is an indication that oil changes should be more frequent, water jacket temperatures are too low (See Paragraph 303), or a different oil used. It is especially important to watch this in winter time.

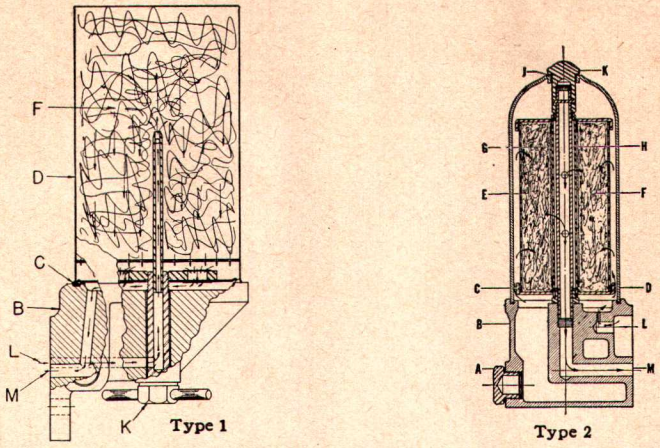


Figure 4—Waukesha Duo-Flo Waste Type Oil Filters
A—Drain plug. B—Base casting. C—Bottom of filter cartridge shell. D—Filter housing. E—Perforated housing for waste filtering element. F—White cotton waste. G—Wire screen center wall of filter cartridge. H—Return tube. J—Gasket. K—Nut; remove this to disassemble and renew filter element. L—Dirty oil enters. M—Clean oil to crankcase. Inverted type of Radial Flow filter has nut K on top of base casting.

103 — Oil Filters — Usually, complete maintenance instructions for oil filters are furnished by the filter manufacturers and appear in the form of a sticker on the side of the filter itself. Always follow these manufacturer's instructions. The material in this book is intended as supplementary information. In general there are two types of oil filters used; one bolted to a machined pad on the engine crankcase with porting in the crankcase to match connections in the base of the filter itself, Figure 4, Type 2; and the other a separate mounted device with copper tube connections between the main oil header and the crankcase sump, Figure 4, Type 1. The most common type is known as the shunt or by-pass filter which receives a part of the oil from the oil pump, cleans it, and returns it to the crankcase in a continuous operation. The other, found chiefly in the large EL, EK, LS, LK, NK, and LRO six-cylinder engines, is connected into the oiling system so that all of the oil is passed through the filter first before it is delivered to the engine bearings. This is known as the series type. Both types should be cleaned ***every thousand miles or every 50 hours of operation*** under ordinary conditions, and certainly with every crankcase oil change. ***If the bayonet gauge shows that the oil has become thick and very dirty, it is a sure sign that the oil filtering element needs servicing.***

104—Waukesha Duo-Flo Waste Filter —As shown in Figure 4, there are two types of waste-packed filters which are in common use. The simplest and most easily serviced is the one indicated as Type 1. It consists of a base with drilled passages, central tube and a filter shell. Oil passes through the central tube, is forced through the white cotton waste and returns to the oil line through the drilled passages in the base casting. Servicing this filter merely requires unscrewing a retaining nut which permits the removal of the waste-filled can and replacement with a new can. Another type, similar to this, used on some of the smaller engines, has a filter can which screws directly into the base casting instead of having a retaining nut. Both operate on the same principle; both have throw-away type of cartridge and cannot be re-used. The filter shown as Type 2 is a more elaborate design but operates on the same principle. For servicing, first drain the excess oil and sludge from the base element by removing the drain plug, A. Then remove the top nut, K, being sure to keep the gasket between it and the shell in good condition. This permits the removal of the shell, D, which exposes the waste-packed cartridge, E. In some types, this cartridge has removable ends so that the old waste element can be taken out and replaced with fresh white cotton machinists' waste. Those which have welded ends should be

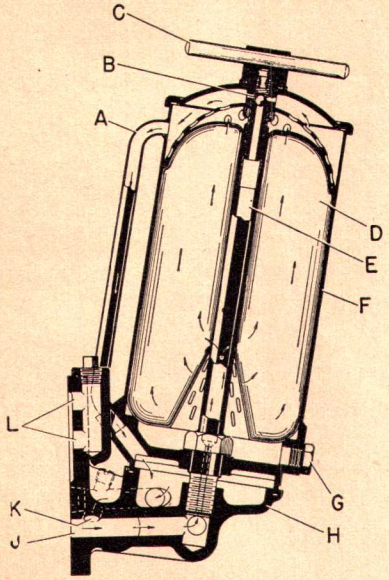
thrown away and a new cartridge substituted. Service parts for these filters are obtainable at all automotive supply houses and are very inexpensive. It is much cheaper to maintain the filter and replace the waste-packed element than to re-fit bearings and re-bore cylinders. After the filter is serviced, be sure to add enough fresh oil to the engine to make up for the loss which has been drained from the filter housing. ***Never use wool waste, it will not remove the dirt.***

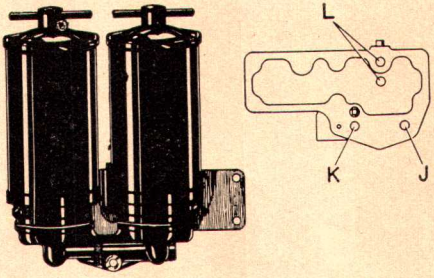
*105—**Deluxe Filter***—The Deluxe Filter shown in Figure 5 may be found on models WAL, WAK, NK, EL, EK, LS, LK, and LRO. It is a replaceable element type, complete instruction for its use being furnished with the filter.

*106—**Horizontal Filter***—Models WAL and WAK are frequently furnished with the horizontal filter shown in Figure 5. This is a cotton waste-packed type with complete instructions for use accompanying the filter.

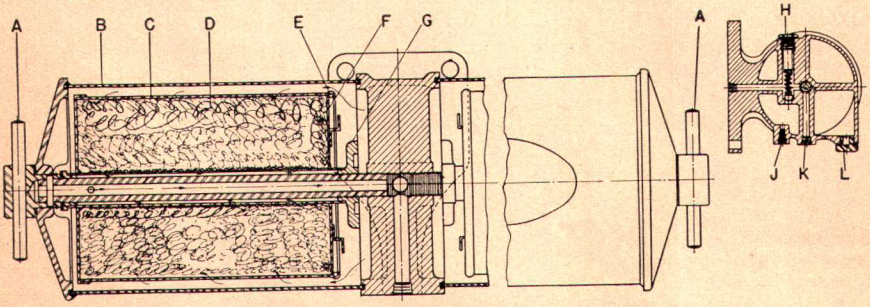
*107—**Crane Continuous Refiner***—This is a separately mounted filter used with some large engine installations. Complete instructions accompany each filter.

*108—**Waukesha Super-Duty Filter***—For many big engines having a large oil supply, a Super-Duty filter has been designed, shown in Figure 6, which operates on the waste element principle but which has a very long life between cleaning periods. This filter is a shunt type having a large drum casing held





A—Oil Return Line. B—Relief Valve. C—Cover Retaining Nut. D—Filter Cartridge. E—Oil Inlet Line. F—Outer Shell. G—Drain Plug. H—Base Casting. J—Oil Inlet. K—Oil Outlet. L—By-pass Line.



A—T-Handled Screw Which Holds Filter Shell Assemblies to Body Casting. B—Filter Shell Integral With Head. C—Perforated Cage Holds Filtering Element. D—White Cotton Machinists' Waste—Wool Waste Must Not Be Used. E—Spring Ring Holds Head of Element Cage. F—Head of Element Cage. G—Brass Wing Nut Holds Loaded Element Cage on Supporting Tube. H—Relief Valve Prevents Clogged Filter From Bursting. J—Connection From Main Oil Header in Engine Supplying Oil to Be Filtered. K—Cleaned Oil Returns to Crankcase. L—Drain Plug; This Must Be Removed First in Servicing Filter.

Figure 5—Deluxe (top) and Horizontal Type (bottom) Oil Filters

to a central return tube by the nut, A. It is mounted on a separate bracket attached to the engine. For servicing, first, shut off the oil flow to the filter by closing the needle valve, D, then remove the drain plug, H, from the casing to drain the surplus oil and sludge. Next, remove the nut, A, which permits withdrawal of the cover and exposes a second nut, B, which holds the filter element head plate, C. With the header plate removed, the cotton waste packing can be withdrawn and fresh, clean waste inserted. Be sure to pack the new waste firmly and draw down the retaining nut, B, when the cage is filled.

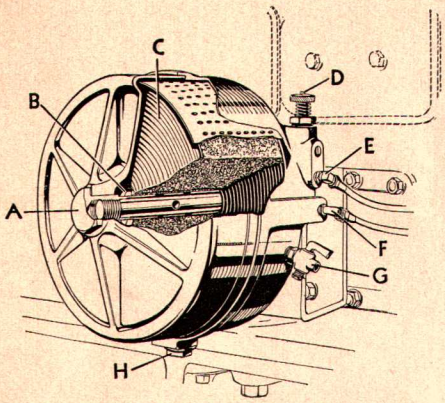


Figure 6—Super-Duty Shunt Type Oil Filter

A—Cover retaining nut. B—Nut holding filter element head plate. C—Filter element head plate. D—Needle valve. E—Lead in line. F—Return line. G—Sampling cock. H—Drain plug.

DO NOT USE WOOL WASTE UNDER ANY CIRCUMSTANCES. After re-assembling the case, open the valve, D, and the filter immediately goes into operation. The frequency of servicing, of course, differs with different engines in different duties. For this reason, the sampling cock, G, on the side of the case has been installed so that oil may be drawn from the filter for observation. This should be done daily and when the oil removed shows signs of becoming black, the filter element should be replaced.

109—Grease Cups—The water pumps on some engines do not require any grease because special oil-less bearings are used. All other engines are provided with water pump grease cups which require a turn a day while the engine is in service. Use a light WATER PUMP grease that is insoluble in water at or below 210° F. ORDINARY CUP GREASE WILL NOT DO. Too much grease as well as the wrong kind of grease will work into the cooling system and coat the cylinders and radiator. Impaired cooling will result. ***Don't allow dirt to get into the cups.*** (See inside back cover for additional water pump lubrication information.)

110—Cooling Fan—In industrial service and continuous automotive service the lubrication of the cooling fan is often neglected. This is very dangerous because in continuous duty these bearings are under heavy load and a failure of the lubrication will cause more damage than just ruined fan bearings —often a radiator will be destroyed through neglect of this important lubricating point. Every fan hub which has an oiler fitting between the blades and belt pulley should receive periodical lubrication with a special high-duty fan lubricant. Fans are supplied with specific lubrication instructions in the form of a Decalcomania transfer on the fan blade so that regardless of type or size, there is no question as to the proper lubricant.

111—Ignition, Starting and Lighting—As these units are not all alike, and are often installed outside by the engine purchaser, it is advisable to follow the accessory maker's directions which accompany the electric units. Electric units having ball bearings require light machine or gun oil and only a few drops of this when used.

112—Winter Lubrication—As shown in the Lubrication Recommendations on the inside covers of this book, there are three temperature ranges, each one of which calls for a different viscosity of crankcase oil. Oil and grease thicken in cold weather and free circulation to the vital parts of the engine is retarded. In industrial engines that are in daily use during cold weather, it is a good practice to add three to five per cent of light lubricating oil to the gasoline. If a sudden cold snap occurs while summer oil is in the engine, circulation of the oil will start quicker if a small amount of kerosene is added. Then, at the end of the day's run, the crankcase should be drained and winter oil put in.

PART III

INSPECTION

MAKE IT AT REGULAR INTERVALS

200—Periodical Inspection—To insure perfect performance in the field, and cut down repairs, nothing will pay bigger profits than a thorough cleaning and inspection at definite periods. Unless it is done regularly it is likely to be done in a careless, haphazard way, and indifferent results will be obtained.

201—Don't Put It Off—It does not pay to correct troubles on operating time. Proper periodical inspection will reveal needed attention, and permit the adjustment or repair before serious trouble results. It can be done at a time when it will cause no delays, and at a place where the facilities make it simple and easy.

202—Daily Inspection—

a. ***Oil and Water***—Check oil and water level.

b. ***Water Pump and Fan***—Check water pump and fan lubrication.

c. ***Air Cleaners***—See that both the breather and carburetor air cleaners are not clogged. In some services, this may need attention several times daily.

203—Weekly Inspection—

a. ***Remove Dirt***—Clean the engine thoroughly on the outside, using kerosene and a brush to remove all the accumulated grease and dirt.

b. ***Test Compression in the Cylinders***—If the compression is weak in any of the cylinders it is the signal to inspect the tappet clearance, and possibly grind valves, or replace some of the piston rings.

c. ***Inspect Spark Plugs***—Clean the plugs and see that the insulators are not cracked. Check the spark gaps, and set them to the proper opening. (See paragraph 518.) When replacing them see that all the spark plug gaskets are tight.

d. ***Check Water Leaks***—Be sure that the cylinder head is tight and shows no signs of leaks. Where there are hose connections, tighten the clamps of any that leak. Check the water manifold flange on the cylinders and heads for leakage. Examine both water pump glands while the engine is running and adjust them if they are leaking.

e. ***Tighten Any Loose Bolts or Nuts***—Cylinder head stud nuts, water pump clamp bolts, front gear cover bolts, and underpan nuts are the most important. Oil leakage will invariably indicate loose joints. Check the engine hold-down bolts and see that they are tight.

204—Monthly Inspection—

a. ***Listen for Unusual Noises***—Knocks usually indicate loose bearings, worn parts or parts out of adjustment.

b. ***Check Valve Tappet Clearance.***—See Tabulated Data for proper clearance.

c. ***Check Wire Insulation and Connectors***—See that all wire terminals are tight on the wires and binding posts. Clean all oil or dirt from them. If any wires are chafed, replace them before they cause trouble.

d. ***Inspect Distributor or Magneto Breaker Points***—The points should be cleaned and the gap properly adjusted. The spark timing must be checked after cleaning the breaker points. The proper method of timing is given in paragraphs 500-514.

e. ***Tighten Fan Belt***—It is very important to see that the fan belt is kept properly adjusted, otherwise the engine is likely to overheat, especially in warm weather. If alcohol is being used as an anti-freeze, do not remove the fan belt at any time. If no anti-freeze is used, it may be advisable to run in extreme weather without a fan belt unless it also drives the water pump or other units.

f. ***Drain Crankcase, Clean Oil Filter and Oil Pump Screen***—When the oil is drained, the oil filter should be flushed and the oil pump screen should be removed and cleaned. Be sure to check the oil pressure after the new oil is warm.

g. ***Determining Overhaul Time***—During the monthly inspection make all tests as outlined in paragraph 203 and decide whether to regrind the valves, take up the bearings, or make other major repairs.

h. ***Annual Overhaul***—The Waukesha Motor Company operates a special shop where by factory standards and methods, customers' engines can be re-built and made new. Operators of contractors equipment find it good economy to use this service annually. A flat rate system insures to owners the greatest satisfaction. It is not expensive!

PART IV
COOLING SYSTEM

300—General Description—There are two methods of cooling Waukesha Engines—thermo-syphon circulation used on the smaller size four-cylinder engines and pump circulation used on all others.

301—Thermo-syphon System—Thermo-syphon cooling depends on the difference in temperatures between the water in the engine and in the radiator. The hot water rises to the top, passes over to the radiator where, as it cools, it falls to the bottom because of its greater weight, and passes back to the engine.

302—Pump System—In all large sizes the pump cooling system is employed. Water from the radiator is led to the pump which forces it under pressure through the water jackets of the engine, and back to the radiator for cooling. With a positive pressure behind it, thorough cooling is assured for even the largest engines, and space is saved.

There are two types of water pump used in Waukesha Engines. One is mounted on the side of the engine and driven by a coupling through the timing gears. Figure 7 illustrates this pump, as well as showing typical water drain locations. The other type is a combination fan and water pump which is mounted on the front of the cylinder block. It is described and illustrated on page 31 (Figure 29).

303 — Water Temperatures — Except when the engine has just been started, cooling water should enter at a temperature of not less than 150° F. and should leave the top of the engine at 170° to 190° F. (With engines operating at 60% or less load, use the upper limit.) These temperatures should be maintained the year round.

304—Radiators—Radiators used for cooling will be large enough to meet all normal loads, if ***frequent addition of water*** is ***not required.*** The addition of a small amount daily is a fair indication that the engine is operating at an efficient temperature. An engine that is cooled too much is as much to be avoided as one that is undercooled.

In many cases, where the engine operates much of the time on part load at reduced speeds, or is idled for long periods of time, it is necessary to cover part or all of the radiator to make sure that proper operating temperatures are maintained. Over-cooling causes condensation and crankcase dilution, which usually results in excessive wear.

305—By-Pass Thermostat—Many Waukesha six-cylinder truck engines are equipped with the by-pass thermostat shown in Figure 8 which operates as follows:

When the engine is cold, the entire volume of the water pump is by-passed as indicated by the solid arrows in Figure 8. This provides a re-circulation throughout the engine so that warm water surrounds the entire length of the cylinder walls almost immediately. As the water becomes hot, the bellows in the thermostat expand to raise the valve from its seat and permit part of the water to flow to the radiator, as shown by the dotted arrows. When normal operating temperature is reached, the full volume is directed to the radiator. At least once a year, inspect the thermostat and replace if necessary.

Whenever the thermostat is removed for any cause, the by-pass line must be blocked to insure full flow through the radiator.

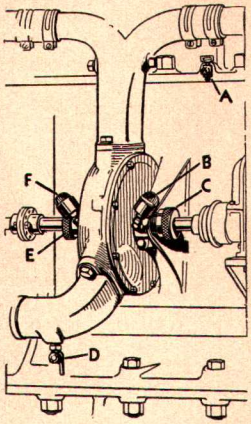


Figure 7—Shaft Driven Water Pump

A—Drain cock at bottom of cylinder water jacket; (there may be one on each cylinder block). B—Grease cup. C—Pump packing nut. D—Drain at base of water pump inlet—this may be a pipe plug in some engines. E—Pump packing nut. F—Grease cup. (Note: Pumps without grease cups are fitted with oilless bearings.)

COLD WEATHER SUGGESTIONS

306—Cover the Radiator—For efficient winter operation and to avoid excessive wear, covering part or all of the radiator is imperative. Temperatures given in Paragraph 303 should be maintained winter and summer. In extreme sub-zero weather, it may be necessary to keep the oil pan covered with heat insulation of some kind to secure the best running conditions. To avoid cooling system freeze-ups, a solution of denatured alcohol and water or ethylene glycol is recommended, because it is non-corrosive and will not damage the radiator, pump, or other parts. The following table

gives freezing temperatures of alcohol and water ***anti-freeze.***

Pure Methyl Wood Alcohol	Denatured Wood Alcohol	Ethylene Glycol ("Prestone")	Radiator Glycerine (G.P.A.)	Freezes at Degrees F.	C.
13%	17%	16%	37%	+20	−7
20%	26%	25%	55%	+10	−12
27%	34%	33%	70%	0	−18
32%	40%	39%	81%	−10	−23
37%	46%	44%	92%	−20	−29
40%	53%	48%	100%	−30	−35

To prevent rust with straight alcohol and water solutions, add two ounces of soluble oil for every gallon of solution in the system

307—Alcohol Evaporation—Add a small amount of alcohol from time to time to take care of evaporation. A hydrometer should be used daily during cold weather to keep the solution up to proper strength.

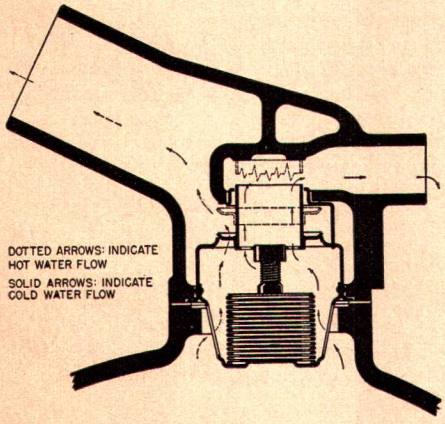


Figure 8—Thermostat By-Pass Used on Six-Cylinder Truck Engines

308—Winter Lay-Up—When an engine is to be laid up during the winter, considerable damage may be done unless the following suggestions are carried out. First, drain all water and fuel from the engine. Second, through the spark-plug or petcock openings pour at least one ounce of heavy cylinder oil. Third, remove the ignition device, and store it in a warm, dry place. Fourth, cover all finished parts with a rust preventing compound, slushing grease or transmission oil. Fifth, cover all openings—exhaust pipe, carburetor intake, breather, and similar ports into the engine—with waterproof fabric or gasket material to keep out moisture and foreign objects and prevent internal damage. When restoring the engine to service, it is advisable to replace all water hose connections and pump packings.

INADEQUATE COOLING

309—Overheating—When an engine overheats it is due to either one of two conditions; inadequate cooling capacity for the peculiar conditions under which it is operated, or some internal change in the engine or cooling system itself. The first trouble, unless it is due to clogged or restricted air passages, is usually beyond the control of the operator, the second, directly in his hands.

310—Check Oil and Water First—This is a universal rule for safety.

311—Lack of Circulation—If the system is full of water, the agitation observed through the radiator filler opening will indicate the amount and character of the circulation. If there is no agitation, it indicates either complete stoppage of the system somewhere, or that the water pump is not working. If light weight hose is used it is possible for the lower hose, connecting the radiator and water pump, to collapse due to pump suction, and thus shut off water circulation. New hose or a brass spring slipped inside the hose will correct this trouble. After an engine has been in service for a long time it is possible for the inner lining of the hose connections to come loose, and shut off or restrict the flow of cooling water. Lack of circulation may also be caused by obstructions in the radiator due to deposits from the water used, or to oat meal, bran or similar material used to remedy a water leak. An obstructed radiator is usually indicated by the tendency of the water to run out the overflow pipe whenever the system is filled with water, and the engine is running at governed top speed.

312—Leak Stoppers Cause Overheating—Don't use oat meal, bran, or similar remedies to stop a leak. Such substances are likely to get into the water pump or its connections, and obstruct them. This will cause serious overheating.

313—Alkali Water Common Cause—When a Waukesha Engine is used in a country where there is much alkali or lime in the water it should be cooled with rain or distilled water if possible. Otherwise the cylinders will soon lime up, and when this scale becomes thick enough, the cylinders will overheat and crack. When alkali water must be used, it is advisable to use a softening treatment such as "Scalina" made by the Rathbun Company of El Paso, Texas, or "Quick Solvent" made by Quick Products of San Antonio, Texas. If this is not practical, fill the system once a season, and then never

change the water, and add only what is necessary to keep the system full. In this way, the minimum quantity of alkali is added, and scaling is reduced to a minimum.

314—Fan Belt Slipping—A belt stretches as it is used, and unless it is adjusted to take up the slack, it will not drive the fan fast enough to properly cool the engine. Convenient means are provided to adjust the belt tension, so there should be no excuse for running with a slack belt. "V" belts should not run as taut as flat belts. (See paragraph 705.)

315 — Carburetor Choke — The choke should never be left closed or partially closed when an engine is running. The closing of the choke increases the richness of the mixture. Rich mixtures always heat up the engine, waste fuel and burn the exhaust valves. ***Always see that the choke valve is wide open when the engine is running.*** If the carburetor is improperly adjusted, it will cause heating like a partially closed choke valve.

316—Leaky Valves—Leaky valves, especially the exhaust valves, will cause an engine to overheat. They become very hot due to the gas leaking past them, and then cause pre-ignition which further aggravates the trouble.

317—Leaky Piston Rings—Piston rings which leak, permit the hot gases of the explosion to blow by, and heat up the pistons. This carries or burns the lubricant from the cylinder and piston walls. Heating the piston causes it to expand, thus reducing the clearance between it and the cylinder wall. This increases the piston friction, and with reduced lubrication, it not only causes overheating, but seriously damages the cylinders and pistons.

318—Improper Spark Timing—Do not run with a retarded spark. On the other hand the engine should not be run with too much spark advance. The Tabulated Data gives the greatest permissible spark advance for each engine using gas or gasoline. ***Excessive advance*** may not be indicated by "detonation" or "ping" as with a conventional engine, but pre-ignition will still take place, and overheating will follow. ***The bearings will also be unduly punished by the severity of the explosion.***

MAINTAINING THE COOLING SYSTEM

319—Draining the Cooling System—Drain cocks are fitted to all Waukesha Engines and Power Units, and are located at the lowest points of the cooling system. If no anti-freeze solution is used in cold weather, the entire system must be drained every time the engine is stopped for a prolonged period. Make sure that none of the drain cocks are overlooked. On all engines there is a drain on the bottom of the water pump; there should be one at the bottom of the radiator; and there may be one on each cylinder block at the low water line if the cooling water enters the cylinder block above the bottom of the water jacket.

320—Cleaning the Cooling System—At least once a year the cooling system should be given a treatment with washing soda solution to remove the sludge and sediment that accumulates. The easiest way is to drain the system, measure the amount of water withdrawn, and put back half of that quantity of fresh water. Then bring to a boil the same amount of water, and add all the common washing soda that it will dissolve. While it is still hot, add it to the cooling system to completely fill it. Run the engine as usual for 24 hours, then drain, flush thoroughly, and refill with clean water.

321—Packing the Pump—Water pumps that are equipped with stuffing boxes will require occasional re-packing to prevent leaks. Any good steam piston rod packing in string form, like Palmetto, will be satisfactory. Remove all the old packing, clean the shaft and gland box and wind in as much as the box will hold. Bring down the packing nuts enough to stop any leaks but not so tight as to act as a brake on the pump shaft. (See Figure 7.)

322 — Pump Lubrication — When the pump is down for inspection or repairs, be sure to inspect the bearings and replace if necessary. In any event, clean them and see that the oil passages are free to make sure that lubricant is reaching them. If oil seals are used, be sure they are in good condition. Stoppage of the oil passages in the pump housing is the most frequent cause of lubricant failing to reach the bearings.

PART V

CARBURETION SYSTEM

400—Fuel Burning—Waukesha Engines are designed to run on several different kinds of fuel, depending chiefly upon the class of service in which they may be used. But no matter what the ***fuel itself*** may be, its economical and satisfactory use depends upon its ***being properly prepared before it enters the combustion chamber.*** This ***preparation*** invariably ***includes*** the ***mixing with*** a definite proportion of ***air*** and ***may include*** the ***addition*** of ***heat*** in a greater or less degree. The mixing and proportioning of the air and fuel is called carburetion and the device which does this is a carburetor.

401—Heavy Fuels—Liquid fuels such as kerosene are too heavy and not volatile enough to properly vaporize without special carbureting and manifolding equipment. For this reason they should only be used in those engines specially built to handle these fuels. Usually a special kerosene carburetor will be attached, and a special intake manifold with a high capacity hot spot will be used. Engines designed for heavy fuels will not be so economical on gasoline, nor will a gasoline engine be so efficient if run on kerosene. ***Stick to the fuel for which the engine was designed to get the greatest satisfaction.*** (See paragraph 707.)

402—Natural or Artificial Gas—Many engines are used where natural or artificial gas is the most economical fuel, and wherever this is possible, the Stromberg or Ensign Gas Carburetor and Fuel Regulator give excellent results. The Waukesha Operator's Card, No. 1016, gives important instructions for piping and cleaning the gas, while rules for adjustment and attachment of the carburetor itself will be found on a separate sheet published by the makers. It is important that a scrubber tank be installed in the fuel supply line whenever natural gas is used for fuel as this prevents dirt, crude oil, or any other foreign matter from getting into the carburetor. Special cylinder heads, intake manifolds and carburetors are supplied whenever the engine is non-portable, and will ***only*** use gas for fuel. Otherwise a standard gasoline engine with a combination gas and gasoline carburetor is most common. Engines equipped for natural or artificial gas only, carry a name plate attached to each cylinder head to identify them. If an engine that has operated satisfactorily on gas, produces an intense spark knock when running under load with gasoline, it is an indication that special gas cylinder heads have been used. Write to the Company for advice if gasoline operation is to be permanent. (See paragraph 707.)

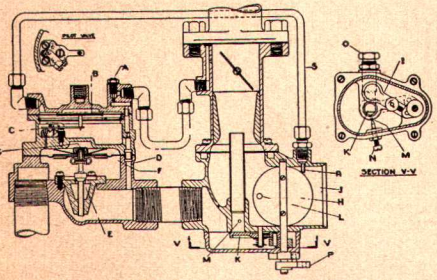


Figure 9—Ensign Gas Carburetor and Fuel Regulator

A—Idle fuel adjustment. B—Upper or pilot diaphragm. C—Pilot valve. D—Section passage from engine. E—Main fuel supply valve. F—Main diaphragm. G—Restricted passage. H—Air choke for starting. I—Gas shutter. J—Air intake. K—Gas passage. L—Air orifice in choke. M—Gas orifice used in choking. N—Adjustment for gas passage. O—Main fuel adjustment. P—Choke lever. R—Nozzle in atmosphere by-pass to regulator diaphragm. S—Atmosphere by-pass to regulator diaphragm.

403—Fuel Pumps—To deliver liquid fuel to the carburetor, many engines are equipped with a fuel pump. There are two general types used on Waukesha Engines; the reciprocating type, shown in Figure 10, and the rotary type used for the largest engines where greater capacity is needed. In the case of the reciprocating type, the only attention required is to remove and clean the glass trap, "K." Do not dismantle either type, but in case of failure, remove the entire unit and have it adjusted or replaced at the maker's local service department.

404—The Carburetor—Do Not Monkey with the Carburetor—As stated above the carburetor's duty is to measure out fuel and air in definite proportions, and prepare it for burning in the cylinder. If too much air is admitted the mixture burns so slowly that it continues burning through the exhaust stroke, and ignites the next incoming charge

which pops back through the carburetor. If too little air is used it cannot produce complete combustion, and part of the fuel is wasted. It is thus necessary to have ***these proportions accurate*** within very ***close limits,*** and if an engine runs well, ***don't*** disturb the carburetor adjustments.

405—Setting the Carburetor—Before starting any adjustments, be sure they are required. Check the fuel supply, the fuel line, the fuel strainers, and make sure that the flow has not been obstructed. Drain the carburetor by opening the petcock or plugged hole in the float chamber to be sure no water has collected there. If fuel does not flow freely from this opening, the pipe line is clogged. If the carburetor continuously drips, the float or float valve may be leaking or improperly set for a too high level. Read the carburetor maker's manual thoroughly, and follow his instructions for details of adjustment and setting. If no manual is at hand, the general principles of adjusting all carburetors here outlined will give fair to good results.

CARBURETOR ADJUSTING

406—Low Speed Adjustment—In making carburetor adjustments the usual object is to secure the best pulling power possible. This does not necessarily mean the highest or lowest speed or best economy of the engine. When adjusting the carburetor, first set the spark in the position found most favorable for pulling, and leave it there while making all adjustments. The idling adjustment should be made first, with the gas control nearly closed. If the engine loads up or seems logy, it is an indication that the mixture is too rich. If the engine slows down and pops in the carburetor, the mixture is too lean. Adjustment should be made accordingly—by the low speed adjustment only.

407—High Speed Adjustment—In making the high speed adjustment, do not change the spark control, but set the gas throttle about one-fourth open, that is, one-fourth away from the closed position. The high speed adjustment should then be turned either right or left, depending on which way it gives the desired effect, until the engine runs smoothly. If possible make this adjustment with the ***engine under load,*** so ***that*** if a ***governor*** is used, it ***will not be affecting the adjustment.*** When the desired results are thus obtained, retard the throttle control, and allow the engine to idle for at least one minute. When this is done, quickly open the throttle about one-third and then quickly close it. If the mixture is too lean, it will pop back through the carburetor, indicating that the high speed fuel feed adjustment must be opened slightly, or if an air adjustment is used, the air flow slightly decreased. If the mixture is too rich, a popping noise will come from the muffler or exhaust outlet, and the high speed fuel feed adjustment should be closed slightly or the air adjustment opened to the desired position. A little experience and careful attention will make possible all carburetor adjustments which may be necessary, but if the engine is working well, ***don't experiment.*** The best pulling power will be obtained with a mixture slightly richer than the leanest mixture that will give smooth running.

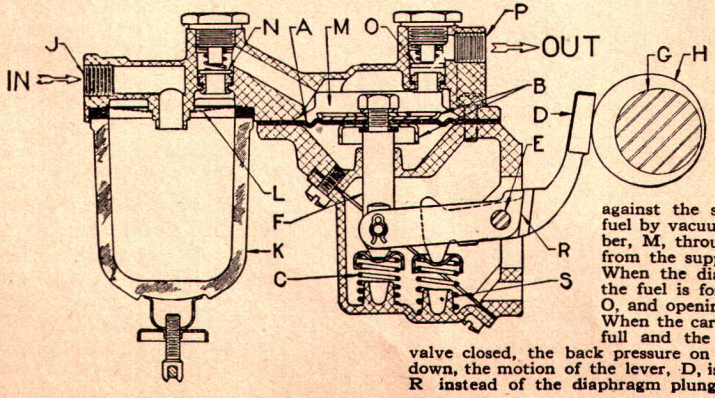


Figure 10—Operation Diagram of Typical Reciprocating Fuel Pump

The eccentric, H, on revolving shaft, G, moves the lever, D, back and forth, and pulls diaphragm plunger, F, up and down against the spring, C. This draws fuel by vacuum into the upper chamber, M, through the check valve, N, from the supply line connected at J. When the diaphragm, A, moves up, the fuel is forced through the valve, O, and opening, P, to the carburetor. When the carburetor float chamber is full and the float holds the needle valve closed, the back pressure on the diaphragm holds it down, the motion of the lever, D, is absorbed by the joint, R instead of the diaphragm plunger, F.

PART VI

THE IGNITION SYSTEM

500—Firing Order—The standard firing order for all Waukesha Engines is:
All Four Cylinder Engines **EXCEPT** Models FCS, FS, FL, FC, FK: 1–2–4–3
Four Cylinder Engines, Models FCS, FS, FL, FC, FK: 1-3-4-2.
All Six Cylinder Engines, no exceptions: 1–5–3–6–2–4.

501—General Principles—There are two types of ignition in general use—the magneto system and the battery system—that can be applied to Waukesha Engines. The magneto is self-energizing, and produces a spark by current which is generated within it. It requires no outside source of electric energy. The battery system, on the other hand, is not self-sufficient but requires a distributor device, a coil, and a charged storage battery, all suitably connected, and some device to keep the battery charged.

502—Spark Plugs—To complete the ignition system, whichever may be used, spark plugs are required, at least one to each cylinder, which must be connected to the ignition device by specially insulated high tension wires.

503—Timing of Ignition—It is impossible to specify definitely the exact timing to get the best results with all fuels and under all conditions of operation. It is important, however, to notice that there is a very definite limit which differs in the same engine with different fuels. Before attempting to do any timing, be sure to refer to the tabulated data and pick the correct top limit for the spark advance and for the fuel to be used. Do not be afraid to retard the spark if the advance specified produces a heavy spark knock. Likewise, the spark may be advanced slightly if the engine runs quietly as to detonation. Generally speaking, the more advanced the spark is, the best the fuel economy and power unless detonation is severe.

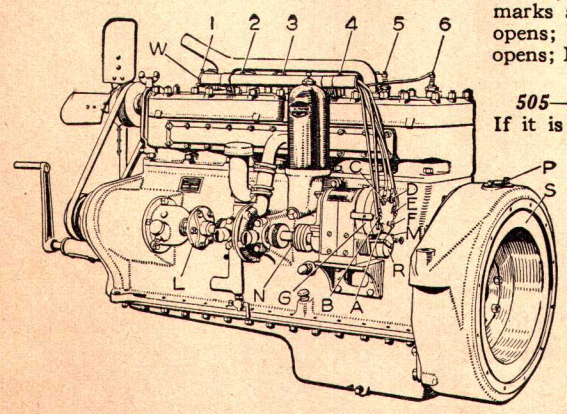


Figure 11—Magneto Ignition and Wiring Scheme

A–B–C–D–E–F—Wires from magneto to spark plugs. G—Magneto distributor block. L—Flexible coupling between drive shaft and water pump. M—Magneto breaker arm for advancing spark. N—Adjustable coupling and impulse starter on magneto. Coupling provides means for adjusting ignition timing. P—Cover over flywheel inspection opening through which the timing marks on the flywheel may be observed when timing ignition or valves. R—Cover over magneto circuit breaker. S—Flywheel.

504—Timing A Magneto—The magneto may be held in place on its bracket by four cap screws screwed into the bottom of the magneto or by a strap, and connected to the drive shaft through an adjustable coupling, so that it is easily disconnected or timed when necessary. If the engine crankshaft has been turned while the magneto was off or the wires were not marked before removal, proceed in the following way to retime the magneto after it has been replaced on its bracket. See that the screws holding the adjustable part of the coupling are released, and that the magneto is thus positively disconnected from the drive shaft at the coupling N, Figure 11. Then refer to the marks on the flywheel which may be observed through the opening P, where there is a pointer to which the marks on the wheel should be brought. The flywheel is marked to show the top dead center for No. 1 cylinder (DC-1). Do not confuse this with the other marks and their meanings as IN-O, intake opens; IN-C, intake closes; EX-O, exhaust opens; EX-C, exhaust closes.

505—Timing with Cylinder Head Off—If it is impossible to see the marks on the flywheel or they are illegible and the front cylinder head is off, it will be easy to bring the No. 1 piston to top dead center. Be sure that both valves are closed. This indicates the firing stroke, whereas if the exhaust valve were closing and the intake just starting to open it would indicate the beginning of the suction stroke, although the piston might be in the same position. Then proceed according to paragraph 507.

506—Timing by Compression Pressure—If the cylinder head is in place, remove No. 1 spark plug, put the thumb over the opening and have the engine cranked slowly by hand. When the compression reaches a maximum, No. 1 piston is on top dead center ready to fire.

507—Ready to Set Magneto— With the piston of No. 1 cylinder set on top and firing center, it is ready for timing the magneto. The magneto breaker box is shown at R, Fig. 11, with the advance arm attached to it, M. The magneto is fully ***retarded*** when the arm is pulled as far as it will go in the direction of rotation when the engine is running. With the cap screws which clamp the adjustable magneto coupling loose, the coupling, N, Figure 11, may be rotated by hand until the distributor arm and the circuit breaker are in their firing position. To avoid a false timing, when an impulse coupling is used, turn the magneto until the impulse coupling snaps, then turn it ***back*** to locate the firing point.

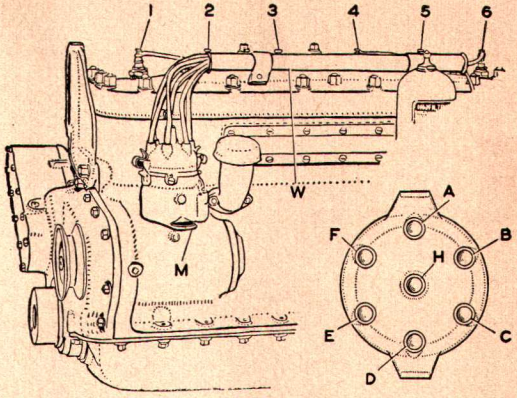


Figure 12—Battery Ignition and Wiring Scheme

A–B–C–D–E–F are wires from distributor to spark plugs. H—High tension wire which carries current to distributor head from outside coil. M—Distributor arm for advancing or retarding ignition. W—Wiring manifold. 1–2–3–4–5–6—Spark plugs.

508—Locating Distributor Arm — Now remove the magneto distributor block, G, and note the position of the distributor arm. It should be in a position that will send current through the wire which goes to No. 1 cylinder spark plug when the block, G, is in place. If it does not, rotate the magneto impulse coupling, see paragraph 507, until it is in that position.

509 — Final Setting — Remove the cover from the breaker box, R, and rotate the magneto shaft just enough to start the breaker points opening. This is the firing point. ***Be sure that the arm, M, Figure 11, is in full retarded position.***

510 — Reclamp Magneto Adjustable Coupling—With these adjustments completed, secure the coupling flanges of the adjustable coupling.

511 — Spark Plug Cables — The wires may now be attached. When taking the wires off an engine it is always most satisfactory to remove them as a unit with the wire manifold, W. For convenience the wires in the order they are attached to the distributor block are designated as A, B, C, D, E, F. The spark plugs are designated according to their cylinder, numbering from the front: 1, 2, 3, 4, 5 and 6. Note, however, that the wires are crossed so that the firing order 1-5-3-6-2-4 may be obtained, so the wiring if properly applied will be A-1, B-5, C-3, D-6, E-2 and F-4.

512—The order of attaching the spark plug cables in the case of a four-cylinder engine would be A-1, B-2, C-4, D-3 to give the firing order, 1, 2, 4, 3; or A-1, B-3, C-4, D-2 for a 1, 3, 4, 2 firing order.

513—Timing a Battery System—Proceed as in paragraphs 504-506. Remove the distributor cap, and note whether the distributor arm is opposite the wire from the spark plug of No. 1 cylinder. The battery distributor is shown in a typical mounting in Figure 12. On the housing is a set screw which holds the distributor in place. Loosen this so that the unit can be lifted high enough to disengage the driving gears. Turn the distributor arm so that it will be under No. 1 wire, and then replace the unit, being careful not to disturb the setting as the driving gears are engaged again.

514—Setting Breaker Points—Now adjust the breaker cam. This can be released from the vertical drive shaft in some way, depending upon the particular ignition system (see the electric equipment maker's instruction book), the cam turned until the breaker points are just opening with the advance lever, M, in full retard position. Lock the cam in this position. In Figure 12, the arrangement of the spark plug leads on top of the distributor head is indicated diagrammatically in a circle. In the center, H is the high tension wire from the coil. The spark plug wire terminals are A–B–C–D–E and F. They should be connected as designated in paragraphs 511 or 512, for six or four-cylinder engines respectively.

MAINTAINING THE IGNITION

515—Spark Plugs—Fouled or defective spark plugs are the most common cause of missing. Fouled spark plugs may be cleaned either by scraping or brushing them with gasoline. If badly carbonized they can be cleaned by burning the carbon off with a blow torch or over a gas burner. Do not use emery or sandpaper to clean the porcelains as it removes the glaze and ruins the plug.

516 — Spark Plugs Defective — With porcelain plugs, broken or cracked porcelains may cause "missing." Mica plugs in which the core is saturated with oil will do likewise. In either case, it is advisable to install a complete new plug.

517—Varying Spark Plug Gap—Some spark plug gaps will not stay adjusted properly under full load temperatures and, as a result, missing will occur under full load after the engine becomes well heated. If they are too wide the engine will miss at low speeds. If too close, they may cause a miss at high speeds. For that reason, it is advisable to use plugs like those originally supplied when the engine was new.

518—Proper Gap Important—Improperly adjusted gaps, caused by careless handling when cleaning, are responsible for much trouble. It is very important that the spark plug points be set about 1/32 inch apart, .025-.030 inch with a feeler gauge.

519—Wiring Troubles—If the plugs are found to be in good condition, inspect all the wiring, and be sure that all terminals are clean and making good contact, as the current will not carry through loose or corroded wires or terminals. Be sure that no wires have been rubbing against some metallic part of the unit so that the insulation is worn off at some point, causing a "short circuit." Oil saturated and dirty wires may also cause missing.

520—Ignition Source—Another common cause of missing with both battery and magneto systems of ignition is sticking of the circuit "breaker points." If they are improperly adjusted or the condenser is defective, they are likely to pit or burn, and then to stick. Cleaning them with sandpaper or a fine file (never use emery cloth), will often remedy the trouble. If it is a bad condenser, however, cleaning the points will not correct the trouble, and either a new condenser must be installed or the ignition unit must be repaired by a specialist.

PART VII
MECHANICAL ADJUSTMENTS

600—General Maintenance—Besides the ***three important maintenance duties, Oiling, Cooling and Fueling,*** there are a number of simple mechanical adjustments the average operator should understand, and make as occasions arise to avoid serious delays. Many times it is desirable merely to recognize the need of them, and have the work done by an experienced mechanic, but even then some rules of procedure will save time and expense. This part of the book, therefore, treats of adjustments to:

Valves and Valve Timing.
Bearings.
Governors.
Accessories.

THE VALVE MECHANISM

601—Testing Valves—To secure the best power and economy, and to avoid missing and overheating, the valves should always seat fully, and hold a charge so that the hand crank will bounce back or "rock" as the engine is turned over. If the engine fails to offer added resistance to the crank on the compression stroke, the leakage can generally be heard as a hiss. If it comes most distinctly through the carburetor, the intake valve is leaking; through the exhaust, the exhaust valve is leaking or if most distinctly through the breather, the leak is past the piston and rings. Leaks at the spark plugs and petcocks can be seen while the engine is running. If any of the valves leak, they should all be inspected and reground.

602—Removing Valves—It is always necessary to remove the cylinder head to take the valves out, and if care is used, injury to the cylinder head gasket will be avoided and a new one ***will not be required.*** The head can generally be loosened by cranking the engine after the hold-down nuts have been removed.

603—Valve Tappets—By examination of the individual engine the workman can determine whether it is easier to remove the tappets or merely screw down the adjusting screw to give clearance for valve grinding. Either way will afford suitable working conditions.

604—Valve Spring Retainers—The end of each valve stem is fitted with a shallow steel cup that surrounds the end of the valve spring, and is held to the stem either by a small horse shoe lock, a pair of wedge blocks or a thread and locking pin. The locking device must be removed before the valve can be withdrawn, and it is advisable to stuff rags beneath the valve stems to prevent these small pieces from falling into the engine or dropping out and becoming lost. To release the lock from the recess in the spring retainer, it is only necessary to pry the retainer up against the spring pressure far enough to push the horse shoe to one side, or let the wedge blocks fall away from the valve stem; with the screw type retainer withdraw the pin from the valve stem, and unscrew the retainer nut.

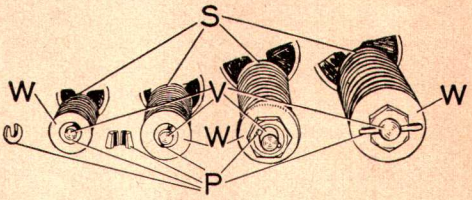


Figure 13—Standard Types of Valve Retainers and Locks

P—Spring retainer lock. S—Valve spring. V—Lower end of valve stem. W—Spring retainer cup

605—Examine Valve Seat—Upon removing each valve, clean it thoroughly, and remove all carbon and burned oil. Carefully inspect the valve and valve seat for deep pits or shoulders that must be machined off before grinding begins.

606—Grinding Equipment—To facilitate the grinding a light spring should be slipped on the valve stem which will serve to lift the valve off the seat when changing its grinding position. Any good commercial grinding compound may be used provided it is not too coarse.

607—Grinding the Valves—Apply the grinding compound sparingly around the entire valve seat, slip the light lifting spring over the stem, lubricate the stem, and drop the valve into its original place in the cylinder block. The spring should just barely hold the valve off its seat. Exhaust valves can be identified from the intake valves by the number of grinding tool recesses in the top face. Exhaust valves have four recesses while intake valves have but two.

608 — Oscillating Motion — Place the grinding tool in the two holes in the head of the valve to be ground. Press down until the valve is seated. Turn the valve a quarter turn, first in one direction, then in the other. Do this three or four times. Release the pressure on the valve, and the little spring will lift it off its seat. Now turn the valve about 10 or 15 degrees to another position, and repeat the grinding. Do this until all the compound is rubbed off the valve seat. Withdraw the valve, and put on some fresh compound. Repeat the grinding operation.

609—Don't Over-Do the Grinding — Clean the valve and its seat occasionally to see how the grinding is progressing. When all pits and grooves have disappeared, place eight or ten equally spaced marks with a soft lead pencil on the cleaned face of the valve seat. Then drop the valve in place, give it a quarter turn, and remove it. A perfect seat will be indicated if every pencil mark shows where the valve has rubbed it. If any pencil marks are left untouched, continue the grinding. When the grinding is completed, oil the valve stem, ***clean all traces of the grinding compound*** from the valve chamber and cylinder walls in the combustion chamber, and re-assemble each valve in its proper port.

610—Don't Forget Tappet Clearance— Refer to the loose insert of Adjustment Data for the proper valve tappet clearance. ***This must be right to avoid valve burning.***

611—Never attempt to adjust the tappets without first releasing the lock nut.

612—Do not use heavy wrenches on the valve tappet adjusting nuts as they are apt to break the tappet.

VALVE TIMING

613—How to Check the Valve Timing— Although the flywheel is marked to indicate the valve timing for No. 1 cylinder, and the gears marked to insure that the camshaft is in correct relation to the crankshaft, it may be necessary on some occasion to check the valve timing. The first step in this operation is to see that the valve tappet clearances are adjusted to the dimensions given in line 16 of the Adjustment Data. Then use the marks on the flywheel referring to the valve setting for No. 1 cylinder which is the one farthest from the flywheel. When the pointer over the flywheel is lined up with the flywheel mark "IN-O", the intake valve should be just starting to open and a very thin feeler placed between the tappet and the valve stem should be pinched. If the feeler is not pinched it is probably because the engine is on the power stroke, and it must be turned one complete revolution to the point where the intake stroke begins. Since all the cams are forged integrally in one piece with the shaft, if one valve is checked all the rest will be properly timed when the tappet clearances are properly adjusted. **AFTER TIMING, RESET THE TAPPETS FOR RUNNING CLEARANCE.**

614—Use of Timing Table—The timing table given below is for use when an engine has been entirely dismantled, and either the timing gear marking or the flywheel marks have been obliterated. Under these conditions, first determine, from the nameplate on the engine, the model and type, and select the corresponding data, ignoring the others. For example, if the engine is a model 6-BK, the timing data which applies is given in the line opposite that model in the table and the camshaft should be set to open the intake valve of No. 1 cylinder five degrees, on the flywheel, after top dead center.

VALVE TIMING DATA FOR WAUKESHA GAS OR GASOLINE ENGINES

Engine Model	Intake Valve		Exhaust Valve	
	Opens	Closes	Opens	Closes
150-U	20° BTDC	60° ABDC	60° BBDC	20° ATDC
Four Cylinder				
ICK	5° ATDC	45° ABDC	45° BBDC	10° ATDC
FCS, FS, FL, FC	5° ATDC	40° ABDC	45° BBDC	5° ATDC
XAH, XAK	10° ATDC	50° ABDC	40° BBDC	15° ATDC
4-55	8° ATDC	35° ABDC	40° BBDC	15° ATDC
130-GS, 130-GL	10° ATDC	40° ABDC	45° BBDC	5° ATDC
VIS, VIM, VIL, VIK	10° ATDC	35° ABDC	40° BBDC	10° ATDC
VRZ	TDC	40° ABDC	40° BBDC	10° ATDC
CHS, CHK	10° ATDC	35° ABDC	40° BBDC	10° ATDC
HS, HL	15° ATDC	35° ABDC	40° BBDC	15° ATDC
4-115	10° ATDC	35° ABDC	40° BBDC	15° ATDC
WS, WL, WK, WOK	10° ATDC	35° ABDC	40° BBDC	15° ATDC
Six Cylinder				
BA, BL, BM, BK, BZ	5° ATDC	40° ABDC	47° BBDC	TDC
MS, ML, MK, MKR, MZ, MZR	8° ATDC	47° ABDC	50° BBDC	8° ATDC
6-110	15° BTDC	64° ABDC	60° BBDC	15° ATDC
SRL, SRLR, SRK, SRKR	8° ATDC	47° ABDC	50° BBDC	8° ATDC
6-125	42° BTDC	90° ABDC	60° BBDC	15° ATDC
RB, RBR	10° ATDC	45° ABDC	40° BBDC	10° ATDC
140-GS, 140-GK (Std.)	5° ATDC	45° ABDC	40° BBDC	10° ATDC
140-GS, 140-GK (Hi Spd.)	15° BTDC	55° ABDC	55° BBDC	15° ATDC
DHK	7½° ATDC	47½° ABDC	40° BBDC	10° ATDC
GAL, GAK	TDC	47° ABDC	45° BBDC	6° ATDC
145-GS, 145-GK (Std.)	5° ATDC	45° ABDC	40° BBDC	10° ATDC
145-GS, 145-GK (Hi Spd.)	5° ATDC	55° ABDC	50° BBDC	10° ATDC
145-GZ (Std.)	5° ATDC	55° ABDC	50° BBDC	10° ATDC
WAL, WAK	TDC	40° ABDC	45° BBDC	10° ATDC
EL, EK, NK	5° BTDC	40° ABDC	40° BBDC	5° ATDC
LS, LK, LRO	8° ATDC	40° ABDC	40° BBDC	10° ATDC

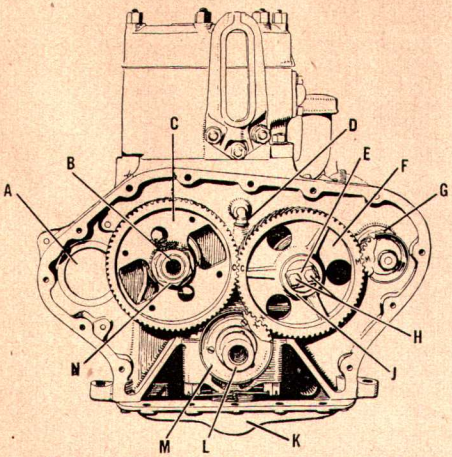


Figure 14—Typical Timing Gear Layout

A—Provision for generator drive gear. B—End of camshaft. C—Camshaft gear. D—Spray nozzle that oils gear faces. E—Lock washer for cap screws. F—Idler gear. G—Magneto drive gear. H—Cap screws which hold washer, J, and idler gear, F, in place. K—Oil pan. L—Crankshaft. M—Oil thrower ring. N—Cam gear lock nut.

615—Check Tappet Clearance—Having checked the opening of the exhaust valve for No. 1 cylinder, it is unnecessary to check the relative setting of the camshaft and crankshaft for any other valves as the cams are all forged integral with the shaft, although the ***tappet clearance of each valve should be carefully checked and set.***

616—Replacing Cylinder Head—There is a best way to replace cylinder heads that should always be followed to prevent trouble later. As shown in the typical case illustrated, the hold-down studs should be tightened in successive stages and in such order as will insure even pressure over the entire surface of the cylinder head and gasket. If the outside nuts are pulled up first instead of the center ones, the head will be cocked, and the gasket will not fit tight enough to prevent burning or blowing out between cylinders. A good torque wrench, obtainable at any large supply house, is recommended for this purpose. Instructions with the wrench will give torque values to be used.

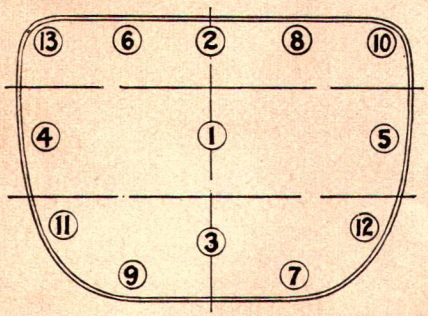


Figure 15—Typical Cylinder Head Layout

The order in which cylinder head nuts should be tightened is shown by consecutive numbering. Pull down snugly the first time. Then repeat drawing each nut tight. After the engine gets hot tighten a third time.

BEARING ADJUSTMENT

617—Taking Up Bearings—It is not advisable for any inexperienced person to attempt bearing adjustment. However, it is necessary for the operator or owner to know the symptoms that indicate the need, and to be able to tell the mechanic who does the work what clearances and tolerances are required.

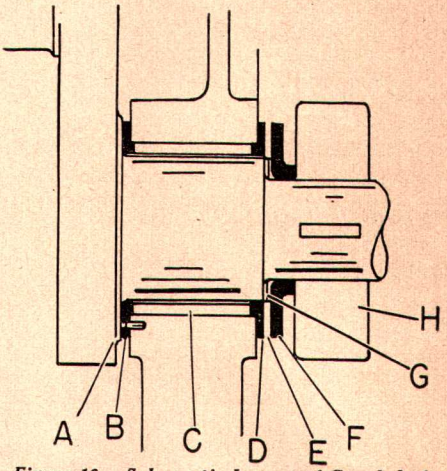


Figure 16 — Schematic Layout of Crankshaft with Adjustable End Play

A—Thrust face of front crankshaft cheek. B—Inside thrust face of front bearing; in some engines this is integral with bearing shell, in others a bronze ring as shown. C—Bearing shell. D—Front thrust ring or bearing flange. E—Clearance for end play. F—Adjustable thrust plate on crankshaft. G—Shims to control end play clearance. H—Crankshaft pinion.

618—Bearing Looseness—In general, any bearing that is loose will cause an abnormal knock that increases with use. The heavier the thump, the greater the need for prompt attention. Call in the mechanic, have him locate the cause of the trouble, and remedy both the cause and the trouble itself.

619—Locating Loose Bearings—A loose connecting rod bearing may be located by running the engine slowly, and short circuiting each spark plug in turn. If any connecting rod bearing is loose, the knock will disappear when that particular cylinder is cut out. A knock in a main bearing is harder to locate, and after all other possible causes of the knock have been investigated and eliminated, remove the spark plugs to prevent the engine from rocking over on compression and injuring your hand, and then remove the oil pan or inspection plate, and try the adjustment of the main bearings.

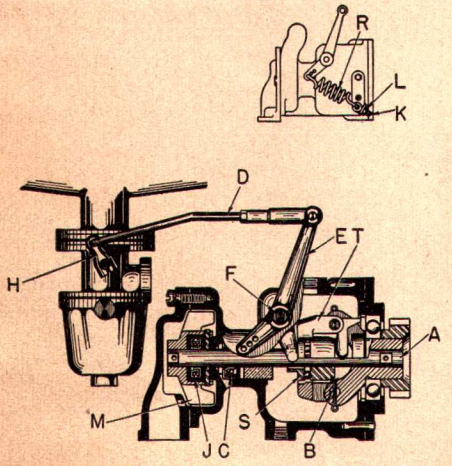
620—Inspecting Main Bearing Caps—It is possible to make an inspection of the main crankshaft bearing caps one at a time without removing the crankshaft. If any trouble has been experienced it will be evident in the cap. If the bearings are loose, but otherwise in good condition, it is possible to take out shims enough to make up for the wear which has taken place. It is very important when doing this to take the same amount out of each of the bearings and each of the shims, otherwise the crankshaft will be thrown out of line, and even as little as a few thousandths of an inch will cause excessive friction in the bearings, wear, and loss of power. Do not remove so many thicknesses of shims that the caps pinch the shaft when the nuts are pulled as tight as possible.

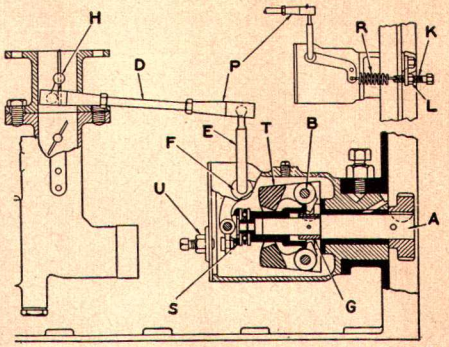
621—Bearing Clearances—The Tabulated Adjustment Data under "Bearing Clearances" gives the manufacturer's tolerances in the assembly of new engines, for running clearance, side clearance, and crankshaft end play clearance—not wear limits. The figures as given should be followed in making readjustments or installing new bearings.

621-A—Crankshaft End Play—Crankshaft end play is non-adjustable in all but eight models—the DHK, GAL, GAK, WAL, WAK, LS, LK, and LRO—and is controlled by the distance between the thrust flanges of the rear main bearing shells, which must be faced to the tolerances shown in Line 25 of the Tabulated Adjustment Data for the model engine being worked on. The total distance between the bearing flanges is equal to the micrometer measurement between the thrust flanges on the crankshaft ***less*** the tolerances given in the Adjustment Data.

621-B—Adjustable End Play—Figure 16 shows the schematic arrangement of the adjustable end play thrust bearing used on Models DHK, GAL, GAK, WAL, WAK, LS, LK, and LRO. In each model the end play is controlled at the front crankshaft bearing, and may employ either a thrust flange integral with the bearing shell, or separate bronze thrust rings doweled to each side of the crankcase bearing housing, but in each case the adjustment and principle of operation is the same. To adjust the end play, first remove the gear cover, and then make the adjustment by using more or fewer shims at G, Figure 16. More shims will increase the clearance E, and fewer will decrease it. A feeler gauge placed in the space E, should be used to determine the amount of end play. Be sure, in taking this measurement, that the thrust surfaces at A and B, Figure 16, are in tight contact. It is not necessary to remove the crankshaft pinion H to take out a shim. The pinion may be backed off ½ inch, and a pair of long-nose pliers used to seize and break one of the shims to remove it. The shims are made of .002-inch shim stock. If shims are to be added to increase the clearance at E, the pinion, H, and thrust plate, F, should be removed and the shim slipped on the shaft. A check of the clearance, E, may be made by tightening the thrust plate with a tube slipped over the shaft and tightened with the retaining nut, and thus avoid the need for pulling the pinion a second time if further adjustment is required.

THE FIVE TYPES OF GOVERNORS





Above — Governor as used on Models FCS, FS, FL, FC, XAH, XAK.

Left — Combination Governor and Water Pump used on Model ICK.

Figure 17—Diagrams of Governors Used on Small Four-Cylinder Engines

A—Governor drive shaft and gear. B—Governor weight hinge pins. C—Water pump seal—external. D—Governor throttle rod. E—Governor lever. F—Governor lever hinge pin. G—Governor weight support keyed to drive shaft. H—Governor throttle valve. J—Water pump seal—internal. K—Speed adjusting screw. L—Adjusting screw lock nut. M—Water pump impeller. P—Throttle rod adjustable ball joint. R—Governor spring. S—Governor ball thrust shift plate. T—Governor weights. U—Stop screw to prevent surging.

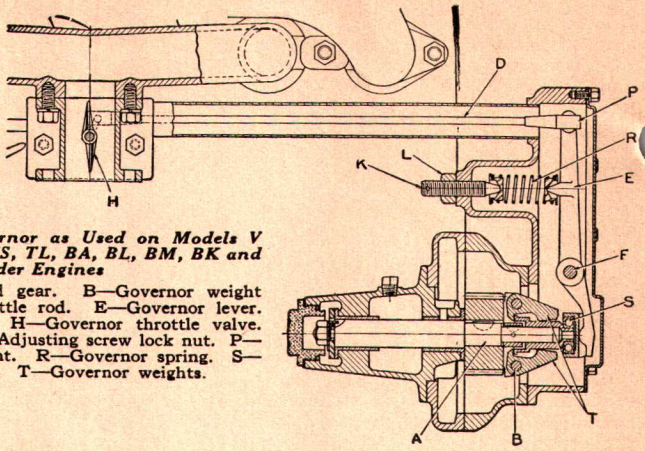


Figure 18—Diagram of Governor as Used on Models V and VK Four-Cylinder, and TS, TL, BA, BL, BM, BK and BZ Six-Cylinder Engines

A—Governor drive shaft and gear. B—Governor weight hinge pins. D—Governor throttle rod. E—Governor lever. F—Governor lever hinge pin. H—Governor throttle valve. K—Speed adjusting screw. L—Adjusting screw lock nut. P—Throttle rod adjustable ball joint. R—Governor spring. S—Governor ball thrust shift plate. T—Governor weights.

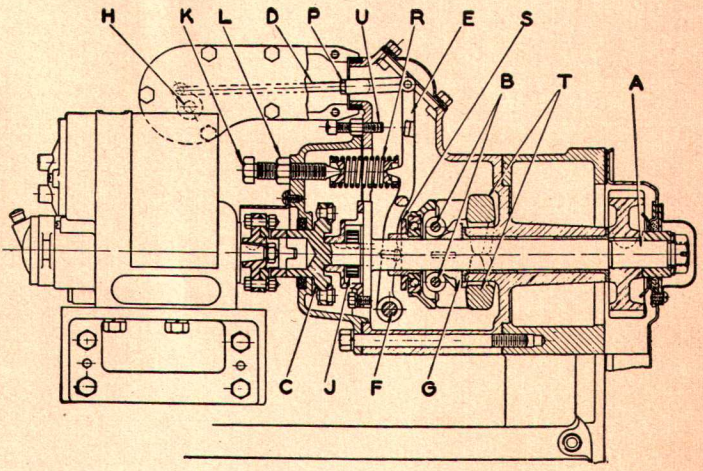


Figure 19—Diagram of Governor for Models VIS, VIL, VIM, VIK, CHS and CHK Overhead Valve Engines

A — Governor drive shaft and gear. B—Governor weight hinge pins. C — Magneto impulse coupling. D—Governor throttle rod. E—Governor lever. F — Governor lever hinge pin. G—Governor weight support keyed to drive shaft. H — Governor throttle valve rod. J—Magneto impulse coupling spring. K — Speed adjusting screw. L—Adjusting screw lock nut. P—Throttle rod adjustable ball joint. R—Governor spring. S—Governor ball thrust shift plate. T — Governor weights. U — Stop screw to prevent surging.

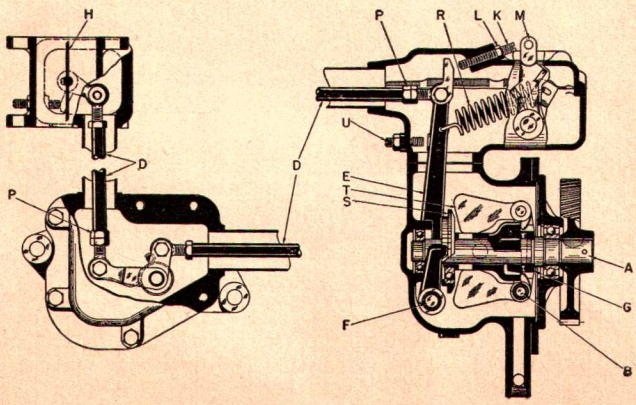
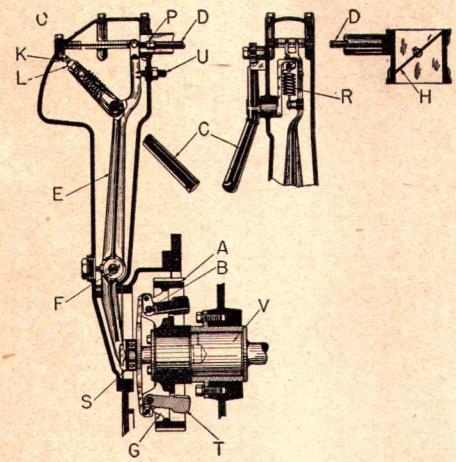
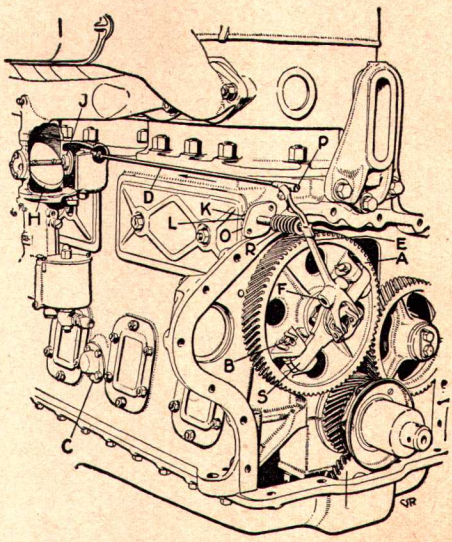


Figure 20 — Diagram of Close Regulating Type Governor Used on Models 6-GAL and 6-GAK

A—Governor drive shaft and gear. B—Governor weight hinge pins. D—Governor throttle rod. E—Governor lever. F—Governor lever hinge pin. G—Governor weight support keyed to drive shaft. H—Governor throttle valve. K—Speed adjusting screw. L—Adjusting screw lock nut. M—Speed adjusting lever. P—Throttle rod adjustable ball joint. R—Governor spring. S—Governor ball thrust shift plate. T—Governor weights.





Above — Governor used on Model 6-LRO.

Right — Governors used on Models HS, HL, WS, WL, WK, WOK, 6-MS, 6-ML, 6-MK, 6-MKR, 6-MZ, 6-MZR, 6-SRS, 6-SRL, 6-SRLR, 6-SRK, 6-SRKR, 6-RB, 6-RBR, 6-EL, 6-EK, 6-NK, 6-LS, 6-LK.

Figure 21—Typical Large Engine Governor Mechanisms.
A—Camshaft gear to which governor weights are attached by pins, B. C—Speed adjusting lever. D—Governor operating rod. E—Governor lever. F—Governor lever pin hole. G—Governor weight support. H—Governor valve. J—Governor valve shaft mounted on ball bearings. K—Speed adjusting screw. L—Adjustment locking nut. O—Governor spring housing. P—Ball joint. R—Governor spring. S—Governor shift plate. T—Governor weights. U—Stop screw to prevent surging. V—Drive shaft.

THE GOVERNOR MECHANISM

622—A Protective Device—The governor built into Waukesha Engines is designed for each particular engine to do two main things 1—to prevent damage from overspeeding as mentioned in the "CAUTION" following the guarantee (see page 4), and 2—to maintain constant speeds automatically under varying loads while driving industrial machinery. ***As the life of any machine falls off rapidly when it is speeded up beyond safe limits,*** the governor should be kept in operation at all times to protect the engine against damage and abuse.

623—Governor Adjusting—The governor is adjusted for the correct speed at the factory, and ***should not be changed*** to a higher speed ***without consulting the Company.*** The general rules given here apply only in those cases where it may be necessary to re-assemble the governor after the manifolds have been taken down or other work done which incidentally involves the governor mechanism.

624—Governor Types—In general principle, all Waukesha governors are alike, and in all but two or three engines, the general arrangement and location of the parts are the same. The general scheme is shown in Figure 21, which applies to the larger sizes, while Figures 17 and 18 show the special arrangement used for the small fours and sixes as indicated by the title, and Figure 19, the type used on valve-in-head engines. Each of these is automatically lubricated by the engine oiling system.

625—Operation of Governor — The operation of the Waukesha governor is as follows: Two weights in the gear chamber attached to gear, A, Figure 21, are held by and swivel around two pins, B. These weights fly out when the engine speeds up, moving the governor shifter, S, outward. This action presses a ball bearing thrust at the center of S, outward. This moves lever, E, Figure 21. This lever, E, swivels on pin, F, which is held in the gear cover. The movement of E, causes a movement of the rod, D, which closes the butterfly valve, H, and throttles the engine independently of the carburetor throttle.

626—Governor Accelerator—In operating some industrial machinery there are periods in the operating cycle which demand an excess of power beyond the routine requirements—raising the loaded skip of a paving mixer, and starting a heavy hoist load are common examples—which can be met by properly connecting the Waukesha governor accelerator. Its action is fully diagrammed in Figure 22, and its use should be restricted to such service as just described.

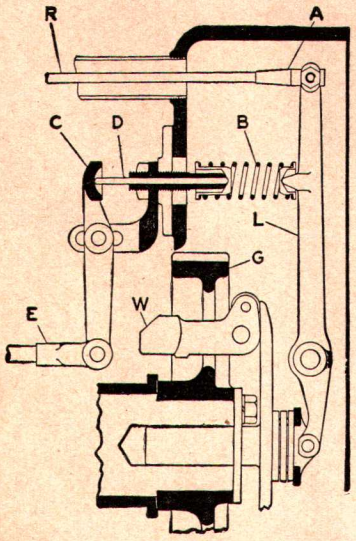


Figure 22—Diagram of Governor Accelerator

A—Ball joint. B—Governor spring which controls maximum engine speed, increasing tension increases speed, reducing tension reduces speed. C—Lever which pushing plunger, D, increases spring tension and engine speed. E—Rod connected to accelerator for remote control by foot pedal or by linkage to operating levers of driven machine. G—Camshaft gear which carries governor weights, W. L—Governor operating lever actuated by governor weights. R—Throttle valve operating rod.

It should not be used for operating the engine ***continuously*** at its maximum accelerated speed.

627—Re-Setting the Governor—As previously stated, governor adjustments should only be necessary if the governor or parts included in its assembly have been taken down for other work such as manifold gasket replacement, timing gear adjustment or gear cover gasket renewal. If any of this work deranges the governor parts be sure that it is re-assembled as it was originally. Make sure that the ball joint lock nut at P, Figure 21, is tight, and that the governor throttle valve is assembled right side up as indicated by the raised letters cast in the edge of the butterfly itself. If all of these points have been carefully followed, the governor should operate exactly as before, provided the tension of the spring, R, or the length of the rod, D, has not been changed. To secure the best regulation, make sure that the length of the rod, D, is adjusted so that the throttle, H, stands a trifle towards the closing position when the engine is stopped. Variation from the speed shown in the Tabulated Data, can be corrected by the screw, K. Turning it clockwise increases the maximum speed, counterclockwise, decreases the speed.

SPECIAL EQUIPMENT

628—Auxiliary Accessories—There are many auxiliary accessories that are applied to Waukesha Engines from time to time, each one usually meeting the special need of some individual client. The principal items include air compressors for air brakes, large capacity electric generators and special cylinder lubricating systems.

AIR BRAKE COMPRESSORS

629—Air Compressors—There are three general types of air compressor mounting, each one designed with automatic lubrication system. The forward chain drive mount-

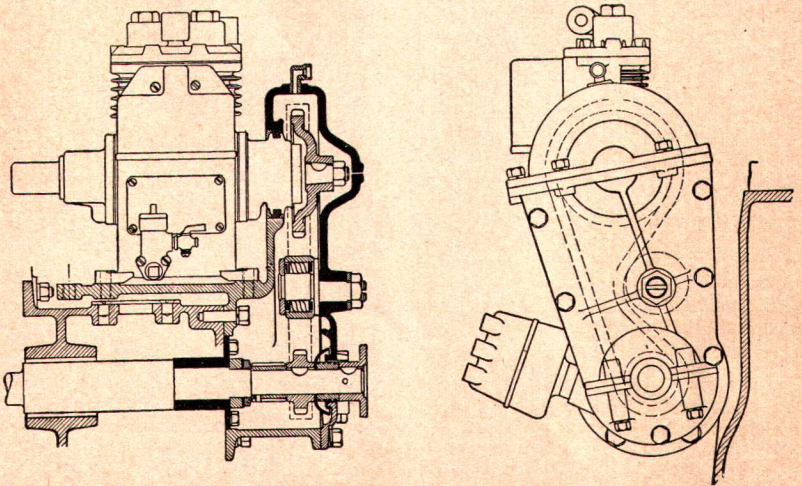


Figure 23—Diagram of Chain Drive Air Compressor Mounting of Early Design; Later Designs Have No Idler.

ing and its typical application to the engine is shown in Figure 23. In this type, the silent chain is entirely enclosed, and receives oil from the engine oiling system. Do not use grease. The chain slack is adjusted either by an idler as shown in the diagram sketch, or by shims being placed beneath the compressor itself. The belt drive forward mounting is too simple to require description. The care of the compressor is covered by the air compressor manufacturer's instruction book. NEVER CHANGE the size of the oil line feed, to do so will unbalance the engine oil distribution.

630—Rear Mounted Compressor—A special bracket replacing the magneto bracket is used for the rear mounting, therefore, battery ignition must be used. As in the case of the front mounted compressor, the lubrication is entirely automatic from the engine system, and does not require any attention. Do not put grease in the gear case. Adjustment of the chain should be made by shims under the compressor base.

ELECTRIC GENERATORS

631—Generator Selection—Occasionally generators for storage battery charging and auxiliary lights are required with capacities from 300 to 800 watts. If, for any reason, this equipment is not furnished by the Waukesha Motor Company and with specific recommendations, it is important that care be exercised in its selection. Make sure that the generator is of the proper size, that it is equipped with a voltage regulator, and that the charging rate is adjusted to meet the electrical load. This will prevent damage to the storage battery.

632—Generator Care—Specific instructions for the care of generators are included in the accessory makers' directions furnished with these units. When the generator is bolted by a flange to the timing gear housing, it is important, in mounting, to see that sufficient back lash be allowed between the generator and driving gears to avoid overheating the generator bearing.

633—Generator Noises—If a rattle or thump is located in the generator at low engine speeds, it can generally be traced to too much back lash in the gears or excessive end play in the generator. Correct the back lash in the gears by loosening the upper attaching screws, and crowding the generator slightly toward the crankcase. This can be done most conveniently if the cap screws are only freed enough to move the generator by light blows from a rawhide or wooden mallet. When proper running conditions are secured, tighten the cap screws. If it is end play, it is controlled in different ways in different machines, and the trouble should be located, and remedied by the nearest service representative of the electrical equipment manufacturer.

SPECIAL LUBRICATION

634—For Special Industrial Service—Extra precautions are necessary to insure ample lubrication of industrial engines that must be started after long periods of rest, or after standing in a cold place. They should be filled with fresh warm oil, and run idle for the first few minutes to permit the oiling system to fill, and insure oil reaching all parts of the engine. It is good practice where industrial equipment stands out of doors overnight in cold weather, to drain the oil from the crankcase each evening and keep it in a warm place, replacing it in the crankcase the following morning. ***Do not put it near a stove or open fire.***

635—Fire Engine Equipment—Fire engine equipment requires special care to avoid serious damage when it is new. Until the engine has been thoroughly limbered by at least 300 hours of service, ***lubricating oil must be added to the fuel***—one pint of oil to each five gallons of gasoline. If the equipment is kept in a station where the temperature is below 50, unless the apparatus is in frequent use, a lighter oil should be used than the standard recommendation given in the Inside Covers of this book. Specifications for this service call for a ***viscosity of 65 to 70 Saybolt at 210 degrees F., not over 600 viscosity at 100 degrees F.*** with a minimum flash point of 420 degrees F. Beside using a lighter oil, the oil supply should be checked frequently, and maintained at top level. When checking the oil supply if the drop from the bayonet gauge is thin and fast, it indicates poor lubricating qualities, and the oil should be changed.

636—Electric Oil Heaters—The most satisfactory arrangement to insure prompt response of the lubricating system is the use of a small electric heater attached to the oil pan sump. This will serve to keep the oil at a proper consistency in the coldest weather, and will also avoid the accumulation of water and gasoline in the sump. Not over 100 to 150 watts are needed. Our Engineering Department will provide suitable sketches on request, showing a permanent attachment of this kind.

DUPLEX OILING

(*Obsolete Equipment*)

637—The Duplex System an "Extra"—In special cases, the added precaution of directly oiling the cylinder walls and pistons is recommended, and for this purpose the

Madison-Kipp Duplex Oiling System was devised. It is auxiliary to and not a substitute for the standard pressure circulating system. It provides a positive delivery of fresh oil in a metered quantity at regular intervals to each piston and cylinder, as soon as the engine starts instead of depending entirely upon crankcase mist for this duty.

638 — Simple Equipment — The extra equipment is securely built into the engine, and consists of an outside oil reservoir with a glass level gauge, and a tube which connects it to a fitting on the outside of the crankcase. The oil in this tank is led to a valveless plunger pump which receives a predetermined quantity of oil, and forces it through a distributing valve to each cylinder in turn. This pump is incorporated in the drive of the main oil pump, and is driven by a worm as shown in Figure 24.

639—Keeping the System Clean—Owing to the small quantities of oil which are used, even with the relatively large oil tubes employed, particles of foreign matter and sludge sometimes collect and stop the system. It has been found that this collects most frequently in the tube leading from the supply tank to the crankcase, and that by blowing out this tube, the system will be restored to full operation. ***Do not*** attempt any ***adjustment*** of the Duplex oil feed ***without*** first clearing this outside delivery pipe.

640—Adjustment of Oil Feed—An adjusting screw is provided at, A, Figure 24. To increase the rate of oil feed, turn the screw counter-clockwise; to decrease the rate of feed, turn it clockwise. This screw may be reached by removing a plug in the side of the oil pan. It is unnecessary to remove the pan for any of the oiling system adjustments. A correct adjustment will add enough oil through the duplex system to balance the normal loss in the circulating system—usually about 11 drops per cylinder per minute—so that between crankcase draining periods all fresh oil is added to the engine through the duplex system. To check the delivery of oil to each cylinder, the small copper tube loop connecting the cylinder with the crankcase may be removed. Watch the oil level carefully, and if it is found to be increasing, reduce the duplex feed rate. If the level is falling, increase the duplex feed rate. Be sure that the oil is not thinning from an over-rich carburetor mixture.

641—Top Cylinder Oiling—When removable sleeve cylinders are used, the Madison-Kipp Duplex System is replaced with the Jay Vacuum Operated "Motop" Oiler. This system is entirely automatic and equipped with a sight gauge, its operation is constantly in view. Follow the manufacturer's instructions accompanying the device if adjustments are needed. Always use the best grade of light oil as recommended by the maker.

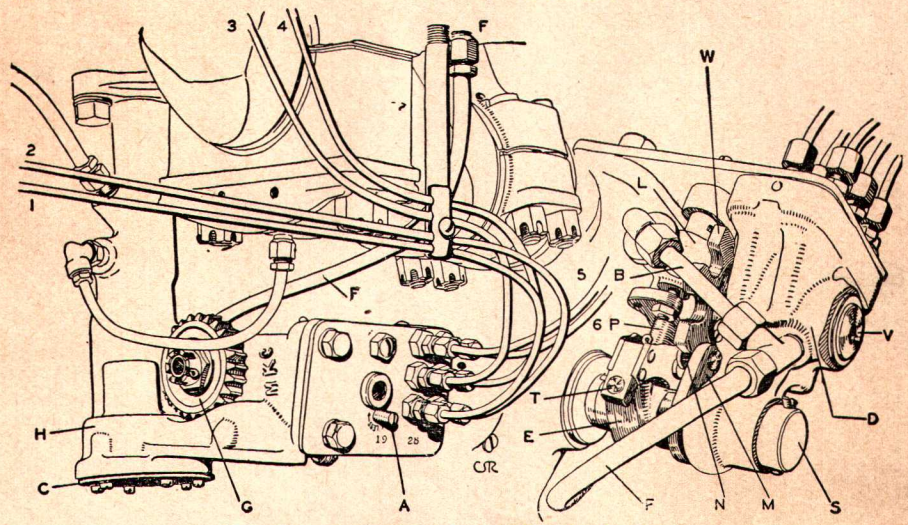


Figure 24—Details of "Duplex" Lubricating Pump

"Fresh oil" leads to their respective cylinders are indicated by the number of the cylinder, i. e., 1-2-3-4-5-6. A—Adjustment screw for regulating "fresh oil" pump. B—Cross over connection from feed line, F, to "fresh oil" pump cylinder, L. C—Cover over oil pump gears. G—Worm gear which drives "fresh oil" auxiliary pump. H—Housing for main oil pump. N—Pin on arm, M, which engages, W, and turns it one notch for each complete revolution of the shaft, S. P—"Fresh oil" pump piston. S—Eccentric shaft driven by worm wheel, G. T—Universal connection on end of piston and connected to driving eccentric, E. V—Rotary distributor valve which directs each shot of the plunger pump to the right cylinder—each cylinder in sequence. W—Distributor valve slow motion gear.

PART VIII

SPECIAL AGRICULTURAL AND INDUSTRIAL ENGINES

700—Special Features—In general, the instructions given heretofore apply equally to the special valve-in-head agricultural and industrial engines as well as the largest industrial sixes. This section of the book details only those maintenance features that require separate mention, such as the special oiling systems for use with the large industrial sixes; manner of removing cylinder heads for overhead valve engines; the removal of sleeve type cylinders; special piston rings; special belt-tightening fan pulleys; and special manifolding.

701—Large Industrial Six Oiling System—The "6-L" Series engines are provided with an oil pump mounted on the front of the base which is driven from the crankshaft pinion and receives its supply of oil from the sump at the front end of the base compartment. At the rear of the crankcase, just back of No. 6 cylinder, is a filler opening with a screw cap through which the engine sump is filled. In these models, all of the oil is held in the base and the proper level is indicated by the bayonet gauge projecting into the sump. Oil taken from the sump is delivered under pressure by the pump, first to the oil filter which cleans it and from there to the main oil header which is bolted to the outside of the crankcase, and which delivers it under full pressure to every bearing in the engine. An oil gauge is inserted in this line, which indicates the pressure. If the pressure falls below the value specified in the inside back cover, stop the engine, locate, and remedy the cause. The pressure regulating valve, mounted on the oil pump, itself, is shown in detail in Figure 3.

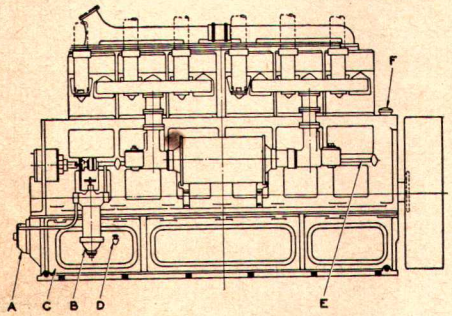


Figure 25—Diagram of Large Industrial Six Oiling System

A—Oil pump with pressure regulating valve. B—Metallic element type oil filter. C—Oil sump. D—Bayonet oil gauge. E—Main oil header. F—Oil filler cap.

702—Lubricating Engines Which Operate in Tilted Positions—For special service where large industrial sixes must operate at extreme fore and aft angles, a special oiling system is required. This special system includes a double scavenger pump which collects the oil from either end of the crankcase and delivers it to the aluminum supply tank just above the water pump. From this tank the oil flows by gravity to the pressure feed pump which is driven by the camshaft and is bolted to the opposite side of the crankcase at the center point. In all other respects, its operation is the same as described in paragraph 701.

703—Removing Cylinder Heads—When valve grinding is necessary, the removal of the cylinder head of all valve-in-head engines is most easily done if the top water manifold and the rocker arm assembly with its shaft and supports are first dismounted. This will permit easy withdrawal of the long push rods and make the cylinder head nuts readily accessible. After this preparation, follow the procedure as suggested in paragraph 602 to 612, inclusive. In replacing the cylinder head, be sure to follow the method described in paragraph 616 and Figure 15, and make certain that the oil line to the rocker arm shaft is secured tightly in place.

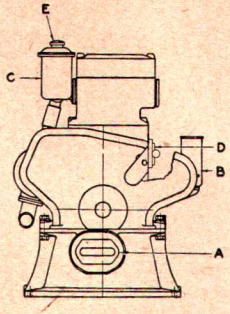


Figure 26—Dry Sump Oiling System

A—Twin scavenger pump. B—H-W filtrator. C—Oil supply tank and cooler. D—Main oil pump with pressure regulating valve receives oil from supply tank. E—Oil filler cap. All oil introduced here.

704—Cylinder Sleeve Removal—In general, Waukesha sleeve cylinder engines are all of the wet sleeve-type which permits simple and easy replacement. The other type which is used only on Models 6-GAL and 6-GAK and some special four-cylinder engines is a thin, dry liner type of super-hard material, and seldom requires replacement. The instructions for replacing the wet liner as given below will not apply to the dry liners. Special tools are required to exert sufficient pressure to remove the dry liners and can be supplied by the Waukesha Service Department. Each *wet* sleeve is sealed by the head and head gasket at the top, while a rubber packing ring fitted in a recessed groove at the bottom of the water jacket case keeps the lower end tight and permits slight expansion as required. To remove the sleeve, simply insert a long bolt with a cross bar at the bottom and another at the top, supporting the latter on two blocks, as shown in Figure 27. Tightening the top nut will release the sleeve, as shown. Be sure that the two blocks supporting the top bar are long enough to be supported across the entire width of the cylinder block. When replacing the sleeve, remove the old rubber ring in the bottom packing groove and insert a new one each time, taking care that none of the old ring falls into the crankcase to clog the oiling system.

705—Fan Pulley Belt Tightening—Some engines are equipped with a special belt-tightening pulley as shown in Figure 28. The outer flange of this pulley is screwed onto the hub, so that by screwing the two flanges closer together, the belt slack is taken up. After adjusting the belt, be sure the set screw is pulled tight and its lock nut brought home.

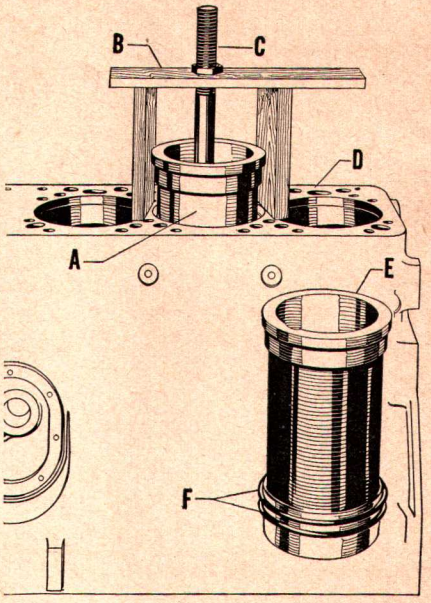


Figure 27—Removing Sleeve-Type Cylinders

A—Old sleeve cylinder being withdrawn. B—Blocking used as yoke for puller. C—Long stud with nut pulls sleeve when nut is screwed down as shown. T-bar across bottom of sleeve is not shown. D—Water jacket and crankcase. E—New sleeve. Head gasket holds joint tight at top flange. F—Rubber sealing rings; some models use two, others only one. Rings are placed in grooves of case before sleeve is pressed in.

706 — Combination Fan and Water Pump—Figure 29 illustrates the combination fan and water pump as used on Models 6-GAL, 6-GAK, and 6-DHK. The entire assembly pivots on a bolt through the discharge port and is adjusted for fan belt tightening by the bolt and slot on the opposite side. A and B, Figure 29, are the Alemite pressure fitting and grease cup respectively. The pressure fitting lubricates the bearings, M; any good standard ball bearing grease will be satisfactory. Bushings are lubricated through the grease cup, B; use No. 6 Mobile, or a similar

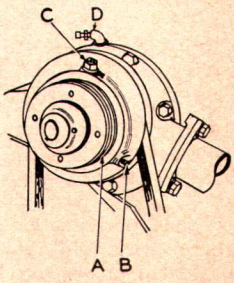


Figure 28—Movable Flange Fan Pulley

A—Pulley hub. B—Adjusting flange screws on hub. C—Set screw with lock nut holds flange in position. D—Pump and fan shaft lubricator.

grease that is insoluble in water. ***Do not use ordinary cup grease.***

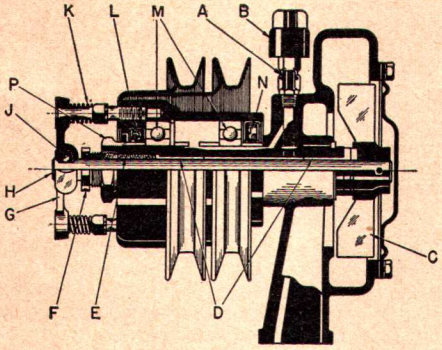


Figure 29—Belt Driven Water Pump

A—Alemite pressure fitting. B—Grease cup. C—Pump impeller. D—Bushings. E—Packing. F—Packing nut. G—Driving spider. H—Pump shaft. J—Pump drive pin. K—Compression spring. L—Oil retainer. M—Bearings. N—Oil retainer. P—Water pump bearing clamp nut.

707—Heat Control Manifolds—Special combination manifolds are found on many agricultural engines which permit the use of either gasoline or kerosene fuel. (See

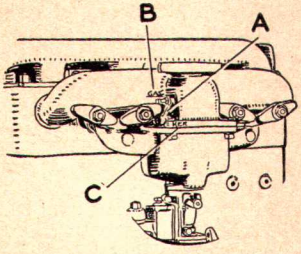


Figure 30—Combination Gasoline-Kerosene Manifold

A—Heat control lever. B—"Gas." C—"Ker."

paragraph 401.) Where these manifolds are like that shown in Figure 30, the heat valve is controlled by the lever so that the amount of heat can be varied. Always be sure that the valve lever points to the word "GAS" when operating on gasoline or to "KER" when kerosene is being used.

708—Fitting Piston Rings to Cylinders—There are two important dimensions to be maintained in fitting piston rings: the gap between the ends when the ring is compressed to the cylinder diameter, and the fit in the groove of the piston itself. The separate Tabulated Data Sheet furnished with this booklet gives the desired fits for both of these dimensions. To fit a piston ring, it is first necessary to slip a piston without the rings into the cylinder so that the top is about an inch below the top of the cylinder, and then place the ring to be fitted into the cylinder and press it against the top of the piston. This insures the ring being square with the bore so that a true measurement of the gap between the ends of the ring can be made. If the ring is even slightly cocked in the bore the apparent gap measurement will be smaller than it really is. Measure the gap with feeler gauges, and if it is too small use a fine file, and take off a small amount on one of the ring tips until it gauges within the limits given in the Tabulated Data. A gap smaller than the low limit given will cause ring seizure and cylinder scoring, while a gap larger than the high limit will cause excessive blow-by, dilution, and sometimes scuffing.

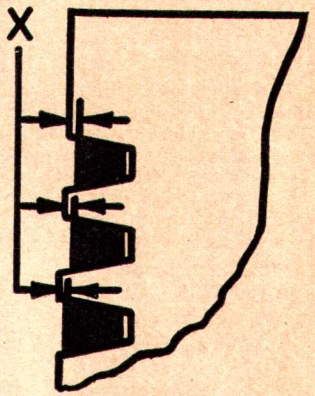


Figure 31—Tapered Piston Rings

709—Tapered Piston Rings—Some models are fitted with tapered piston rings that fit in tapered grooves on the piston. After each ring has been fitted to its cylinder it should fit properly in its groove. Place the ring on the piston and press it into the groove at one place only—not all around—and see that it can be buried below the adjacent lands at least as deep as the minimum dimension given in line 21 of the Tabulated Data for the model in question. Try it at four spots around the piston to make sure the ring can move freely at all points. When wear increases Dimension "X" to the extent that the top limit has been exceeded by .002", the ring should be replaced. Do not mix up rings that have been fitted to one piston and cylinder—they will not run smoothly on any but their own place.

PART IX

SERVICE INSTRUCTIONS

INSTRUCTIONS FOR ORDERING REPAIR PARTS

800—Give Engine Model Number—Always specify ***size, model,*** and ***number*** of the engine, which is stamped on the name plate attached to the crankcase. The engine number is also stamped on the crankcase at either the gear cover or flywheel housing end, also on the front end of the crankshaft. Be sure to give the number stamped after the model, as "6-RB" or "6-AB" or whatever the number may be on the particular engine.

801—Give Description and Quantity Required—Furnish complete description and number, where known, of the part or parts wanted. ***Do not use the word "complete,"*** state exactly each item that is wanted and do not designate the quantity by "sets"; mention ***how many parts are required.*** For instance, if ordering sufficient main bearings for one four-bearing engine say, "Eight halves main bearing bushing—part number so and so," or if the part number is unknown give the engine model number as explained in paragraph 800.

802—Tell How to Ship and Where—State whether the shipment is to be routed by freight, express or parcel post; furnish shipping point and post office address. If shipping instructions are not specified on the order, we will use our judgment, taking into consideration time as well as cost. ***We will not be responsible for any charges by our so doing.***

803—Mail Shipments—Goods shipped by mail are entirely at customer's risk, unless cash or postage for insurance accompanies order.

804—When Shipping to Us—Mail bill of lading or express receipt ***with letter*** of advice. ***Do not enclose*** it ***with*** the ***shipment.***

805—How to Mark Shipment to Us—It is very important to have the crate or the box containing all shipments properly ***marked*** with the ***sender's name*** and ***address,*** otherwise it may not be identified. The best way is to paint or stencil it on the box. Always ***prepay the charges.***

806—Terms on Repairs—To avoid delay, all repairs will be sent C.O.D. unless cash accompanies the order. All prices quoted are F.O.B. Waukesha, Wisconsin.

807—How to Return Parts for Credit—When returning parts for inspection and credit (see Guarantee, page 3), the ***engine number*** from which the parts were taken must be given and all transportation ***charges must be prepaid.*** Our receiving department is not authorized to accept "Collect" shipments.

808—Service Rebuilding—The Service Rebuilding Shop offers owners and users the same degree of manufacturing skill and precision for re-conditioning their engines that were used when first built. Flat rates have been established which make it a simple, easy, safe and sure way of keeping an engine in good condition.

WHEN TO RETURN ENGINES FOR OVERHAUL

809—Engines to Be Overhauled—Many users of Waukesha Engines have little use for them during the Fall and Winter months, and yet wish to use them early in the Spring. Such customers should anticipate their needs. When an engine is to be sent us for repairs, send it early so that we may have plenty of time to overhaul and return it before the Spring rush season starts. The same foresight should be applied when returning parts for repairs or ordering new parts.

810—Parts to Remove from Shipment—When returning an engine for overhauling, remove such parts as spark plugs, priming cups, top water pipe, fan, fan pulley and belt, starting crank, clutch, ignition cable tube and wires, as these parts are likely to be lost or damaged in transit. It will also reduce the weight of shipment and thereby lower the transportation charges. ***Do not remove the intake and exhaust manifolds.***

Form 1131-F—30M—5-45 Printed in U. S. A.

LUBRICATION DATA
for WAUKESHA GAS and GASOLINE ENGINES

TABLE III

Engine Model	Engine Class	Bore and Stroke	Hot Oil Pressure at Gov'd Speed	†Oil Capacity Quarts		Engine Model	Engine Class	Bore and Stroke	Hot Oil Pressure at Gov'd Speed	†Oil Capacity Quarts	
				Auto-motive	Box Base					Auto-motive	Box Base
150-U	B	3 x2¾	40	3	4	6ZKA	B	3⅜x4⅛	40	7	....
ICK	A	2⅛x3⅛	15	3	....	*6BA	B	3⅜x4¼	40	8	12
FCS	A	2¾x4	15	4	8	*6BL	B	3½x4¼	40	8	12
FS	A	2¾x4	15	4	8	*6BM	B	3⅝x4¼	40	8	12
FCL	A	3 x4	15	4	8	*6BK	B	3¾x4¼	40	8	12
FL	A	3 x4	15	4	8	*6BZ	B	4 x4¼	40	8	12
FC	A	3¼x4	15	4	8	6MS	C	3¾x4¾	40	8	....
FK	A	3¼x4	15	4	8	6ML	C	4 x4¾	40	8	....
160	A	3 9/16x3½	15	3	....	6MK, 6MKR, 6MZ, 6MZR	C	4⅛x4¾	40	8	....
XA	B	3½x4½	15	4	9						
XAH	B	3⅝x4½	15	4	9						
XAK	B	3¾x4¾	15	4	9						
130-GS	B	3¾x5	40	6	10	140-GS	C	4¼x5½	40	10	14
130-GL	B	4 x5	40	6	10	140-GK	C	4½x5½	40	10	14
VIS	B	4⅛x5¼	25	8	12	*6SRS	C	4⅛x5⅛	40	10	14
VIM	B	4¼x5¼	25	8	12	*6SRL, *6SRLR, *6SRK, *6SRKR	C	4⅜x5⅛	40	10	14
VIL	B	4⅜x5¼	25	8	12						
VIK	B	4½x5¼	25	8	12						
VRZ	B	4⅝x5¼	25	8	12						
CHS	C	4¾x6¼	25	15	15	145-GS	C	4¾x6	40	18	26
CHK	C	5⅛x6¼	25	15	15	145-GK	C	5¼x6	40	18	26
HS	C	5½x6½	30	14	17	145-GZ	C	5⅜x6	50	18	....
HL	C	6 x6½	30	14	17	6RB, 6RBR, 6DHK, 6GAL	C	5 x5¾	40	14	....
WS	C	5¾x8	25	14	24						
WL	C	6¼x8	25	14	24						
WK	C	6¾x8	25	14	24						
WOK	C	7½x8	25	14	24	6GAK	C	5½x5½	40	18	30
4-55	B	3⅝x4¾	25	5	....	6WAL	C	5¾x6½	40	32	....
4-95	C	6 x6½	30	14	17	6WAK	C	6¼x6½	40	32	....
4-115	C	6½x7	30	12	20	6EL	C	6½x7	40	....	70
						6EK	C	7 x7	40	....	70
						6NK	C	7 x8½	40	....	70
						6LS	C	7 x8½	40	....	72
						6LK	C	7¾x8½	40	....	72
						6LRO	C	8½x8½	40	....	72
						*6-110	C	4 x4¾	40	8	....
						*6-125	C	4⅜x5⅛	40	10	14

*Engines marked with (*) may have copper lead bearings, oils that attack copper-lead alloys must NOT BE USED. See paragraph 6, page 5.

†Note: Oil capacities listed are for oil pans only. When oil filters, oil coolers and other accessories that require engine oil are installed, an extra amount equal to the capacity of these accessories should be added.

TABLE IV—WATER PUMP LUBRICATION

TYPE OF WATER PUMP	ENGINE MODELS
Ball bearing type pumps with grease sealed bearings. Require no lubrication.	ICK, HS, HL, 130-GS, 130-GL, 140-GS, 140-GK, 145-GS, 145-GK, 145-GZ
Pumps requiring fluid grease, calcium base, non-soluble in water, "Pump Lube" or equivalent.	FC[1], FCS[1], XAH, VIS, VIM, VIK, CHS, CHK, 6-BS[2], 6-BL[2], 6-BM[2], 6-BK[2], 6BZ[2]
Pumps requiring any good waterproof cup grease.	FC[3], FCS[3], WS, WL, WK, WOK, 6-ZL, 6-ZK, 6-BS[4], 6-BM[4], 6-BL[4], 6-BK[4], 6-BZ[4], 6-MS, 6-ML, 6-MK, 6-MZ, 6-MKR, 6-MZR, 6-110, 6-125, 6-SRS, 6-SRL, 6-SRK, 6-SRLR, 6-SRKR, 6-RB, 6-RBR, 6-EL, 6-EK, 6-NK, 6-LS, 6-LK, 6-LRO, 6-DHK, 6-GAL[5], 6-GAK[5]

1. Cylinder head pump.
2. Belt driven pump (Fluid grease for pump bearing. Use ball bearing grease in front bearing.)
3. Side mounted pump.
4. Gear driven pump.
5. Waterproof grease for grease cup. Ball bearing grease in Alemite fitting.

TABLE V—VISCOSITY CONVERSION FOR FOREIGN USE

S.A.E. No.	Saybolt Seconds	Redwood Seconds	Engler Degrees	Kinematic Centistokes
10W	90–120 @ 130° F.	78–106 @ 130° F.	2.6–3.5 @ 130° F.	18.2–25.2 @ 130° F.
20W	120–185 @ 130° F.	106–164 @ 130° F.	3.5–5.4 @ 130° F.	25.2–39.8 @ 130° F.
30	55– 65 @ 210° F.	164–223 @ 130° F.	5.4–7.4 @ 130° F.	8.8–11.6 @ 210° F.
40	65– 80 @ 210° F.	57– 70 @ 210° F.	2.0–2.4 @ 210° F.	11.6–15.6 @ 210° F.
50	80–105 @ 210° F.	70– 93 @ 210° F.	2.4–3.1 @ 210° F.	15.6–21.6 @ 210° F.
60	105–125 @ 210° F.	93–110 @ 210° F.	3.1–3.7 @ 210° F.	21.6–26.2 @ 210° F.