General Service Manual

Second Edition

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Continental Motors Corporation

DETROIT, MICHIGAN MUSKEGON, MICHIGAN

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GENERAL SERVICE MANUAL

of

The RED SEAL CONTINENTAL MOTOR

Second Edition

CONTINENTAL MOTORS CORPORATION

Offices: Detroit, Michigan

Factories: Detroit, Muskegon

Largest Exclusive Motor Manufacturer in the World

Above—Detroit Plant *Below—Muskegon Plant*

FOREWORD

The Continental Motors Corporation has been manufacturing internal combustion engines for the past 28 years. In fact this company is the oldest exclusive manufacturer of this class of equipment in the world. Continental engines have been used in the finest passenger cars and the sturdiest commercial vehicles for many years.

The trade name "Red Seal" stands for all that is best in power units for quality vehicles and dependable industrial equipment. The large number of engines produced during the many years of the company's existence has made the service field an attractive one and, as a result, inexperienced parts manufacturers have entered the replacement business, offering to the service trade a line of replacement parts. In general, the products of such companies are inferior, often being made of a material not suitable for the purpose intended and for this reason these parts can be sold cheaper than the genuine article. This cheapness of first cost is often the sole sales argument of manufacturers of this class. Of course in the end this is the most costly and the few cents, and even dollars, saved in the beginning is lost because of the necessity of frequent removals and unsatisfactory service while they do last. The sensible owner will use only genuine parts. The advantage of the garage man using only genuine replacements will ultimately be greater through an increased number of satisfied customers.

PREFACE

The engines, referred to in the following pages, are manufactured for passenger cars, commercial installations and industrial purposes. For the purposes intended, they are most dependable units, having built into them the latest designs, finest of materials and accurate workmanship. Properly cared for, they should operate over an indefinite period of time, the length of which will depend on the usage and attention given it.

The principal aim of this manual is to provide the owner-driver, as well as the repairman, with the necessary knowledge to service his engine. In order that the non-technical man may obtain the greatest possible value from this treatise, simple phrases and terms have been used. Lengthy detailed descriptions have been eliminated as they would confuse the layman and, are not required by the expert.

Each major division has been treated separately by first briefly describing the principal part, then noting the possible causes necessitating adjustment and, finally, specific instructions for correcting the resultant error. Each division is complete within itself, but becomes a part of the whole in the case of a complete overhaul.

Attention is called to the necessity of using only GENUINE parts. The owner and mechanic should bear in mind that the Continental Engineering and Research Departments have very carefully gone into the requirements of each and every part, and have specified certain materials and workmanship which result in a product of the very finest degree of perfection. Because of the small difference in cost of the unauthorized and GENUINE part, it is believed that the owner or mechanic cannot afford to forego the guarantee which accompanies each Continental built unit, as is the case when unauthorized parts are used.

The servicing of accessories used in connection with these engines have not been covered in detail. This is because of the many different types and makes of carburetors, magnetos, battery ignition systems, air cleaners, fans, etc. To mention but one would be discriminating, and limitation of space prevents describing all.

Manufacturers of these devices have provided service and maintenance instructions, copies of which are furnished by the builders and manufacturers of the vehicle or Industrial Unit using the engines.

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Cylinder Head and Gasket Replacement

The copper asbestos gasket used in the cylinder head construction of the Red Seal Continental engine is not just simply "a gasket," but is a superior article. The material and workmanship is especially suitable for just the service required. The original gasket may, if carefully removed, be used several times before replacement is required. When finally, through accidental injury or usage, it is necessary to replace, only the GENUINE CONTINENTAL part should be purchased. Unauthorized parts, while cheaper to buy, are many times more costly in the end.

When removing the cylinder head, a sharp chisel or screwdriver never should be used to pry it loose from the cylinder block. The better way is to use two eye bolts screwed in the spark plug holes over the second and next to the last cylinder. A bar is then passed through the two eyes and a chain-fall fastened around the bar.

Figure 1 illustrates the suggested method of removing the L head type cylinder head. While one hand operates the tackle the other is used to lightly tap the lugs provided for that purpose on either side of the head. However, the mechanic should not strike hard enough to break the jacket wall. This will not be necessary if a slight strain is put on the eye bolts with the chain-fall.

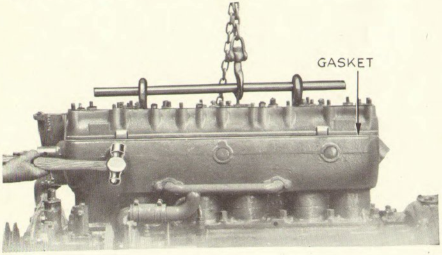

Fig. 1
Removing Cylinder Head with Tackle
This is the approved method. One hand may be used to operate the tackle while with the other lightly tap the lugs on either side of the head

Wherever a chain-fall is not available, the head should be first loosened by striking the hammer bosses. The mechanic should then grasp the head at each end and lift same straight up. Otherwise, the head will become stuck on the studs and there is a possibility of injuring the mechanic's hands.

Whenever the head is removed for any purpose, it will also be advisable to remove the head gasket. It should be raised evenly, exercising care that it is not bent out of shape, by catching on one or more of the studs. The same precaution is to be taken when replacing or when installing a new one.

On the Valve-in-head (or overhead valve) type of engine a suitable link or lifting ring is provided to which a chain-fall may be fastened for removing the cylinder head. Before removing the head, however, be sure that the rocker shaft, rocker arms and reach rods are removed.

After the head nuts are removed the lifting ring can be screwed onto a stud provided for that purpose and the head removed. After reinstalling the head when reassembling reach rods, rocker shafts, and rocker arms, be sure that the oil hole in the rocker shaft is properly indexed with the oil hole dowell in the front rocker shaft support.

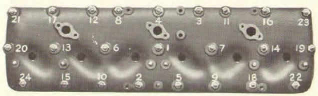

Fig. 2
Top View of Cylinder Head
Nuts are to be drawn down in the order indicated by the numbers.

When reassembling either type of head make sure that the gasket is assembled so that the water circulating holes in the gasket properly index with similar holes in the block and head. Shellac or gasket cement should not at any time be used on this joint. A liberal smearing of motor oil on both sides is all that is required. The mechanic should make certain, before pressing the gasket into place, that all foreign matter, such as chips, carbon, etc., has been removed. If this is not done, a water leak in the bores may result.

With the head reassembled and the stud nuts spun down loosely, the final operation is to tighten them correctly. This simple part of the job is often slighted and leaks, either internal or external, or a cracked head is

the result. The proper method is to lightly tighten all nuts with a speed or socket wrench. Next, go over them again, drawing each one down to a firm but not final setting beginning with the center nuts and working out towards the ends and sides. Figure 2 illustrates the order in which these nuts should be tightened. This procedure is followed repeatedly until each nut is screwed down firmly.

Where a new gasket is installed, it will be necessary to go over the stud nuts after the motor is heated up. This is to compensate for the packing down of a new and comparatively soft gasket. An old gasket, being used the second or third time, will not require this final "take up."

Valve Tappets and Their Adjustments

Of the two types of tappets used in Continental motors, the one with the mushroom head Fig. 3 will be found in most models. The other design is known as the plunger or finger type, Fig. 4.

The mushroom head tappet has a stem of comparatively soft steel which is drilled hollow for lightness. The alloy steel head is of a hardness

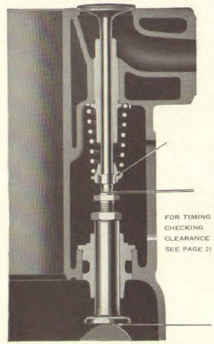

Fig. 3
Valve and Operating Mechanism Sectional Mushroom Head Type

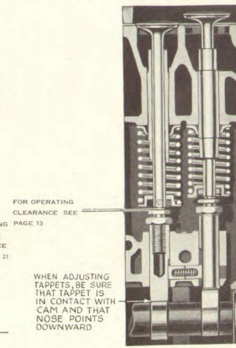

Fig. 4
Valve and Operating Mechanism Sectional Straight Plunger or Finger Type

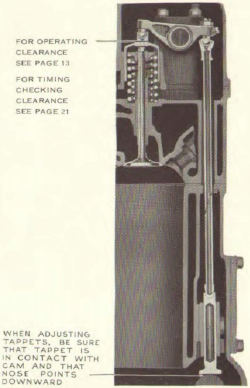

Fig. 5
Valve and Operating Mechanism—Sectional Valve-in-head type Engine

closely approaching that of tool steel, particularly where it comes in contact with the cam. The upper end of the stem is flattened on two sides for an open end tappet wrench. This type of tappet is so designed that when in operation it turns or rotates in the guide.

As shown in the accompanying illustration, the bottom end of the plunger type tappet is rounded on a radius. This, together with the comparatively sharper profile of the cam, gives the same quick action to the valves as the roller type action, but without the latter's disadvantage of being short lived, due to rollers and roller pins wearing rapidly. Unlike the mushroom tappets, these plungers do not rotate in the guide. This is accomplished by interposing between each pair two spring actuated plungers whose outer ends, being flat and true, press against suitably flattened spaces in the side of the tappets.

The adjusting screw clearances are the same for both styles of tappets. For passenger car engines being operated under normal conditions, the recommended clearances are .004″ for inlet valves and .006″ for exhaust unless otherwise specified. With engines applied to busses, trucks, industrial equipment, harvesting machines, boats and the many other diversified installations operating normally the clearances should be increased

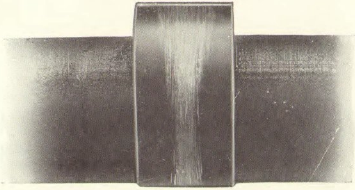

Fig. 6
Scored Cam Face
The scoring of this cam is due to too close tappet adjustment

to .006″ and .008″ respectively. On the other hand where the latter classes of equipment are run at unusually high temperatures the clearances should be increased to .008″ and .010″ respectively. With these clearances the slight tappet noise will be uniform and not unusually noticeable.

The exception to the above is where a plate is fastened to the side of the engine giving the correct operating clearances, or else the proper clearance is stamped on the tappet cover.

Mechanics adjusting tappets are cautioned not to set the tappet adjusting screws closer than outlined above. If this is done when the engine has become heated and the normal expansion takes place, the valves will hold open. The results of such action are obvious. The face of the tappets as well as the cams become badly cut; the head of the valve becomes warped and in some instances badly burned. The illustration shows these conditions to advantage. Figs. 6 and 7.

A mushroom type tappet which has the face not too badly scored can be reconditioned quite easily. This is done by placing a piece of triple naught (000) emery or crocus cloth over a smooth, flat surface, such as a piece of plate glass or similar object, using this as a polishing or lapping table. The tappet should be held firmly and squarely against the abbrasive and given a wide sweeping circular motion. A slightly "frosted" surface will not cause noise and it is not necessary to polish far enough to remove all of the fine hair lines.

With the plunger type tappets, it is not advisable for the mechanic to attempt reconditioning their faces, for to properly reface them, they should be held in a fixture so that the angle will be exactly right. This can be taken care of at the Continental factory. It might be advisable, if the tappets are not too badly worn on the stems or the flat sides, to send them in for reconditioning.

When through natural wear or by cutting as described above, the tappet requires replacement, only the GENUINE CONTINENTAL part should be installed. The maximum amount of wear or looseness is .003 of an inch. That is, when there is this much clearance between the stem of the tappet and its guide hole in the bushing. While there will be no serious results by operating this way or with even greater looseness, the attendant noise will be in direct proportion, and such a condition should be corrected at the earliest convenience.

Continental tappet guide construction is of three types. The first type operates in separate guides, each pair of which is retained in position in the cylinder block by an "H" shaped crab or clamp. Should it be necessary to remove or replace one or more of these groups, care should be exercised when assembling, for each guide assembly must be firmly seated against its collar or flange and the crab adjusted so as to bear evenly on all four of its points.

The second and third types consist of four or six tappets carried in blocks. Each tappet guide block is fastened to the cylinder with two cap screws which pass through hollow pilot bushings. The outside diameter of these bushings accurately fit correspondingly sized counter bored holes in the cylinder bosses and guide blocks. Obviously, the purpose of these pilots is to assure the tappet and guide assemblies being always in proper alignment with regard to the cam faces. The cap screws holding the blocks to the cylinder should at all times be drawn to a uniform tightness.

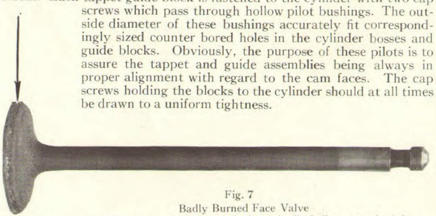

Fig. 7
Badly Burned Face Valve
This condition is not unusual when valve "rides" as a result of the tappet adjustment being too close

When new guides or blocks are required, the mechanic should select those which provide a smooth sliding fit of the tappets, whether this be the original guide fitted with a new tappet, original tappet fitted to a new guide, or where both tappet and guide are new.

Valves and Their Fittings

Continental engineers have given the valve requirements of the various models very careful study, and as a result have developed a very satisfactory valve of the one piece type, that is, the head and stem are forged

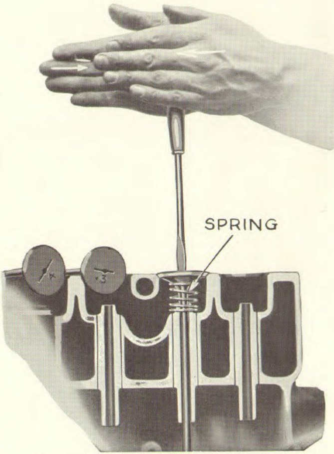

Fig. 8
Valve grinding by hand
Care should be exercised when grinding valve by hand

in one solid piece of special alloy steel. It has been found that a steel which will satisfactorily stand the excessive heat of exhaust gases will also resist the peaning action of the tappets.

In the case of some of the engines, particularly those designed for bus and truck work, special silchrome valves have been designed for the exhaust. The design of valves for certain engines requires that the diameter of the head of the exhaust and intake be of different sizes.

The two most commonly met with causes of valve failure are warped seats and carbonized or warped stems. Both result in two conditions of varying degrees, that is, pitted and burned seats of valves and block, and a loss of compression. These two results are inseparable and rapidly become worse. Leaking valves must be corrected with the least possible delay. Valves which "ride" or remain open because of too close tappet adjustment will also cause trouble through burned seat and warped stem.

The regrinding of valves is not a difficult job, provided each individual operation is given thought and attention. The following procedure is

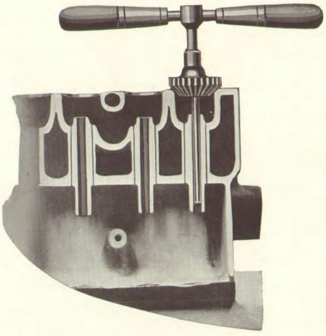

Fig. 9
Facing Valve Seats
A 45° hand cutter is used to remove the scale prior to "lapping in"

recommended. First, of course, the head is to be removed and all of the valve spring retainers disassembled from the lower ends of the valve stems. The springs and conical cups need not be removed, simply lowered to the top of the tappet screw. Next, all of the valves are to be removed and their heads and stems as well as the block parts thoroughly cleaned of all carbon, and the holes in the guides cleaned out and oiled, after which the grinding is to be done.

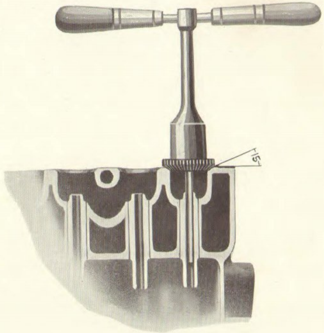

Fig. 10
Relieving Valve Seat Edge
A 15° cutter is used only to relieve edge of seat

Actual grinding operations are in the order named as follows. A small spring should be placed over the end of the stem of the number one valve and assembled in guide. The spring should just raise the valve from its closed position. This is to permit the grinding compound, which is now to be applied sparingly, to flow back and cover the spots or area made bare by the oscillating motion of the valve being ground. A large screwdriver or almost any one of the many mechanical devices now on the market may be used, although an electric grinder is preferable. This is especially true in the event of the service mechanic doing the work.

An abrasive of two grades, medium and fine, is to be used. A small amount is to be coated on the valve face, for any excess is liable to find its way into the valve stem guides, or worse, into the cylinder bores, where but one small grain or particle will be certain to cause trouble. A coarse grade of abrasive is not to be used, for if the seats are in a condition requiring a heavy grind, the purpose can be better served by facing the block seat with a cutter. Under such conditions the valves themselves should be refaced in a lathe or small tool.

Beginning with the medium grade abrasive, all of the valves should be "roughed in," finishing up with the fine grade and finally washing off all grinding compound from valves and block seats and polishing in "metal to metal." From time to time the work should be examined to learn if the operation has been completed. The usual test with Prussian Blue is recommended, or the "lead pencil" test may be more convenient, and is equally sure. To make the latter test a very soft lead pencil should be used, and several marks about ¼ of an inch apart placed around the face of the valve, as illustrated. Fig. 11. If the seating has been correctly done all the lines will have been broken when the valve is replaced and turned ¼ revolution on its seat.

Neither of the facing operations referred to in the preceding paragraph should be carried any further than absolutely necessary to remove the burned or warped surfaces. It is desirable to limit to the minimum the amount of metal removed because the pounding action of the valve in service will have set up a hardness in both the face of the valve and the block. This more dense metal makes an ideal seat and is to be retained insofar as possible. In addition to this, it is not advisable to recess the block seats any more than necessary, for the reasons stated below.

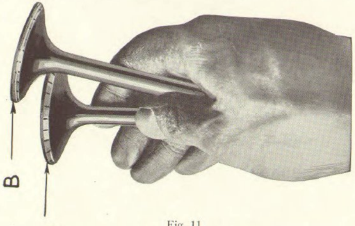

Fig. 11
Valve Faces Marked for Testing
"A" face before test—"B" after test. Note broken lines

After repeated regrinding and refacing operations, the seat face in the block will have been recessed to a point where the face edge of the valve will be flush with, or below the top surface of the block. When this stage is reached, the edges of the seat must be relieved with a 15° cutter. See Fig. 10. Again caution is suggested against removing more metal than is necessary to provide the required seat.

Fig. 12
Standard Valve Property Seated
A standard sized new valve in a new seat

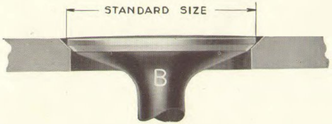

Fig. 13
Standard Valve Countersunk in Seat
Same valve after repeated grindings and use, indicating how a valve becomes countersunk below the surface of the cylinder

While not actually a part of the valve grinding operation, the proper fitting of the valve stems in their guides is very closely associated. Different size engines, of course, require different clearances between the valve stems and their respective guides. However, this should not exceed .005″ in the case of the smaller engines and from .006″ to .007″ in the large engines such as are used for large busses and railway car propulsion.

When larger clearances than the above have been brought about by wear, new valve stem guides will be required. These must be align reamed to such sizes that in the smaller engines the stem clearances will be from .0025″ to .003″, while the larger ones require from .003″ to .004″. Care should be exercised in removing the old guides as well as properly installing the replacing parts. In some Continental engines it does not make any difference which way the old guides are removed and new ones installed; that is, they may be drawn out from the top or driven through the bottom.

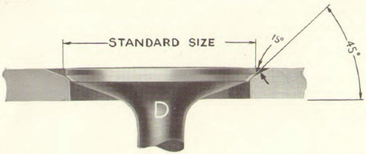

Fig. 14
Standard Valve in Relieved Worn Seat
A standard valve in the countersunk seat. This latter has been relieved on the edges by the 15° cutter as shown previously

Other models use stem guides which have shoulders at the bottom and must, therefore, be driven out through the bottom and replaced in a reversed manner. Some few of the older models have guides with shoulders at the top. This will, of course, necessitate the old guides being pulled out from the top and the new ones driven in in a reversed manner. Where these shoulders or stops are not provided, care should be exercised to make certain that the new parts are installed so that their top ends will be exactly the same distance below the top of the cylinder block as in the case of the old parts being replaced.

Valve Timing

Proper setting of the valves with relation to the crank shaft (Valve Timing) is one of the most important phases of successful motor operation. In all Continental engines, the recommended timing of valves is the result of exhaustive tests. Therefore, the mechanic should never attempt to alter the original factory setting. Some mechanics often believe that they can better the performance of an engine by changing the timing. This is a fallacy, as nothing but harm would be accomplished through such a move. While tabulated data showing the opening and closing of exhaust and intake valves in degrees is quite interesting, and is very frequently used for checking and setting the camshaft, the more practical method is to be governed by the flywheel markings and tappet clearances which will be described in the following paragraph.

To take advantage of the following instructions, a study should be made of the flywheel rim markings as shown in Figs. 15 and 16. The mark **D. C.** when under the flywheel pointer indicates that number one piston is at top dead center, and is about to descend on the intake stroke. When the markings **EX. C.** is just beneath the flywheel pointer, the exhaust valve should have just closed. This should be the case when the tappet adjusting screw is adjusted to permit the clearances between the screw head and the end of the valve stem as outlined in the following table:

8A	.0075	H8	.012	34L	.012	17S	.012
8AP	.0075	H9	.012	37L	.012	18S	.012
9A	.0075	H15	.010	M3	.012	6T	.0075
10A	.0075	H16	.010	M4	.0075	7T	.0075
22A	.012	H17	.010	6M	.0075	8T	.0075
25A	.012	H22	.010	12M	.010	9T	.0075
B2	.005	H23	.010	14M	.010	12T	.0075
B5	.0075	H24	.010	9N	.002	14T	.0075
B7	.0075	H28	.0138	2P	.0075	15T	.0075
6B	.0075	14H	.0075	6P	.002	16T	.0075
8B	.0075	15H	.0075	8P	.008	7U	.0075
C2	.002	16H	.0075	7R	.0075	8U	.008
C4	.004	28H	.0075	8R	.0075	10U	.0075
7C	.0075	J4	.0075	14R	.01375	11U	.0075
12C	.008	6J	.0075	15R	.01375	14U	.0075
14C	.012	7J	.0075	16R	.01375	15U	.012
15C	.012	K4	.0075	18R	.01375	18U	.0075
16C	.012	9K	.0075	19R	.01375	V4	.0075
17C	.012	12K	.012	20R	.01375	V7	.0075
18C	.012	13K	.012	21R	.01375	W4	.0075
E4	.004	14K	.012	29R	.01375	W5	.012
E7	.004	L4	.0075	30R	.01375	W8	.012
6E	.006	L5	.0075	31R	.01375	W9	.012
10E	.008	9L	.012	32R	.01375	W10	.012
11E	.012	14L	.012	S4	.0075	6W	.0075
12E	.008	15L	.012	S5	.0075	7W	.002
14E	.012	18L	.006	S10	.012	14W	.010
15E	.008	19L	.006	S11	.012	Y2	.012
16E	.012	20L	.012	S12	.012	6Y	.0075
17E	.012	24L	.012	S14	.012	7Z	.0075
18E	.012	26L	.012	6S	.0075	12Z	.0075
8F	.008	28L	.012	8S	.007	16Z	.0138
9F	.008	29L	.012	10S	.007	17Z	.0138
H2	.012	30L	.012	14S	.007	18Z	.0138
H6	.0075	31L	.012	15S	.012	19Z	.0138
H7	.012	32L	.012	16S	.012	20Z	.0138

14A.
Chart showing proper tappet clearance for valve timing purposes.

Because of manufacturing tolerances "building up" in one direction in the case of gear driven front ends, it may be that the cam and idler gears will not mesh together exactly, that is a tooth on one gear will not be exactly opposite a space in the other. The mechanic should always bear

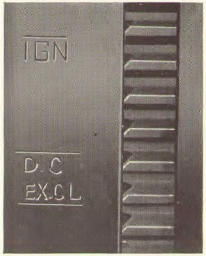

Fig. 15

Valve Timing Flywheel Markings

With the flywheel turned so that the symbol in the center is opposite the pointer, it indicates that number one piston is on top dead center. With the wheel turned so that the lower symbol is opposite the pointer, number one exhaust valve should have just closed. For ignition timing, the wheel should be turned so that the upper symbol is just opposite the pointer

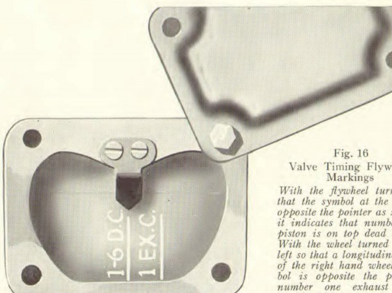

Fig. 16

Valve Timing Flywheel Markings

With the flywheel turned so that the symbol at the left is opposite the pointer as shown, it indicates that number one piston is on top dead center. With the wheel turned to the left so that a longitudinal line of the right hand wheel symbol is opposite the pointer, number one exhaust valve should have just closed

in mind, of course, that the cam gear will turn slightly to the right or to the left (as the case might be) due to the angular pitch of the teeth (in the case of helical cut gears). This turning may be just enough so that when fully in mesh, the cam will be in exactly the correct position for proper "timing." In case this "spiral wind" does not compensate for manufacturing tolerances, advance the cam gear the fractional tooth width necessary for correct meshing. Under no circumstances should the camshaft be retarded (turned to the left) in order to effect the proper meshing.

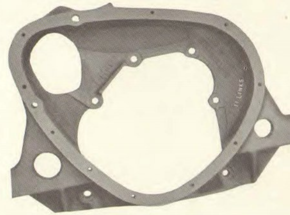

Fig. 17

Cast Iron Chain Case showing number links to be placed between "O's" on camshaft sprocket and crankshaft sprocket

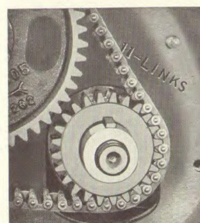

Fig. 18

Sheet steel chain case showing number of links to be placed between "O's" on camshaft sprocket and crankshaft sprocket

Another simple method of checking and correcting valve timing, in the case of the chain driven front end, is as follows: After the chain case cover has been removed it will be found that the camshaft sprocket and crankshaft sprocket have certain timing marks stamped as indicated at "A" and "B," Fig. 43. Upon also examining the chain cases as illustrated in Figs. 17 and 18, it will be found that in the case of the casting the number of links to be placed between the timing marks is cast into the chain case (in the case of the sheet steel chain case, Fig. 18, the number of links is stamped). For example the chain case Fig. 17 specifies 11 links. This means 11 links or 12 chain teeth between the marked spacers on the camshaft and crankshaft sprockets, including the two teeth that are indexed in the marked slots. See Fig. 43.

Frequently owners or mechanics write to the Service Department requesting certain valve setting as measured by travel of the piston. This has been worked out several times and found to be impractical to use. This is because near the top and bottom ends of the stroke, the piston vertical, and crank shaft angular movements are relatively small; so small that the difference between the top dead center and the usual point at which the inlet valve opens can scarcely be noticed by the naked eye. A micrometer depth gauge would be required for measurement. For the reason just given this method of valve timing should never be attempted.

Ignition Timing

The subject of ignition timing of Continental engines can only be dealt with briefly. This is because of the many different types of magneto and battery ignition systems used on the various models. All vehicle and industrial manufacturers include, with their instructions, data issued by the ignition unit manufacturers. These booklets give specific instructions for the setting of their particular make and type of system. Conditions and requirements may vary so that just the correct setting can only be determined by individual tests.

A variable ignition type of magneto and battery system distributor will both require the same setting for the best performance at maximum loads. First determine just how your flywheel rim is marked. If as illustrated in Fig. 16, then turn the crankshaft until the point **D.C.** is just opposite the flywheel pointer. Next the breaker box (in the case of magneto or distributor) body should be set in a fully retarded position. Finally, the cam of the magneto or distributor is to be set so that it has just begun to separate the breaker points. If your flywheel markings is as illustrated in Fig. 15, instead of turning the crankshaft until the **D. C.** mark is just under the pointer, the crankshaft should be turned until the **I G N.** mark is just under the flywheel pointer. Then set the magneto or distributor as outlined above. There may be an occasional instance where the magneto (variable type) will require a slightly greater advance. This is seldom the case, although the average maximum advance of the magneto is but 20°, while the battery type distributor is frequently 30° or more.

Where a magneto of the fixed or set ignition type is used, the timing will vary somewhat from that described in the foregoing. It will vary more or less in each individual installation with the piston on top dead center. The cam and armature will require an advance of from 15 to 30 degrees, which amounts to from $\frac{1}{8}$ to $\frac{3}{16}$ of an inch of piston travel, measured just before the piston reaches top dead center of the compression stroke. It is quite necessary to use an impulse coupling with such extreme advance settings. One caution will apply here, regardless of what make of impulse is used, and this is to make sure that the coupling has tripped before setting the armature or cam.

Connecting Rod Bearings, Their Adjustment and Replacement

On all of the later engines, the connecting rod big end bearings are of the "spun in" type. By this is meant that the babbitt lining or bearing part is an integral part of the rod assembly. The metal is not simply "poured" or die cast into place. Instead, the rod and cap forgings are clamped to a special face plate, which revolves at a high rate of speed. The centrifugal action set up causes the molten metal to be forced out toward the walls of the rod and, in cooling, becomes a very dense mass integral with the rod and its cap forging. The cap is later cut from the rod and the adjoining faces machined.

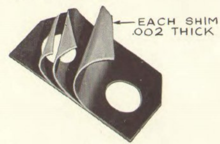

Fig. 19
Bearing Shim
All bearing liners are made up of several .002 thick shims bonded together

Due to the high grade of the babbitt metal, and the process of "spinning in," these rod bearings will withstand more severe usage than any other type. This condition is further enhanced by the design which provides for a very large bearing area, as well as excellent and accurate workmanship in machining and assembling. Added to these fundamentals is a well designed lubricating system, the whole resulting in a harmonious combination that makes for long life.

On all of the older type connecting rods, shims of one form or another were used. However, in some of the later types, shims or liners are not provided, since the machining of the rods and the fit on the shaft are held in very close limits. Where shims are not provided blades or caps should not be filed to compensate for any wear that might have taken place to the bushing, but the rods should be rebushed or replaced with a rebushed rod which is reamed to just the proper size to fit the crankshaft. The test for the proper fit of this type bearing is the same as is used where the shim is employed and is described in detail in the following paragraph.

On the shim type rod when through lack of proper lubrication, or at the end of long service the bearings require adjustment, it is with care and consideration that the mechanic should undertake this operation. There are two alternative procedures. The first is simply the removal of the required number of shims from the liner assemblies (two of the latter to each rod). The second is to remove the rod and piston assemblies complete so that the piston pin and ring fits may be noted. The latter and complete job is recommended, and will be described in the following paragraphs.

After the removal of the oil pan, the crankshaft is to be turned so that the two end crank pins are at their lowest points of travel. The cotter pins, nuts, caps and liners are to be removed, the lower ends of the rods swung over the crank pins, the caps liners and nuts loosely reassembled, and the piston assemblies withdrawn from the bores. The crank is then to be turned until two other rods are accessible and the operation repeated on the other rod and piston assemblies. Next, all of the assemblies are to be cleaned with gasoline or kerosene, and such corrections made in regard to piston pins and rings as may be found necessary.

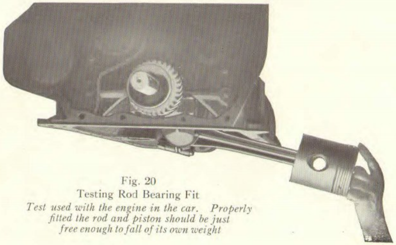

Fig. 20
Testing Rod Bearing Fit
Test used with the engine in the car. Properly fitted the rod and piston should be just free enough to fall of its own weight

In the case of the drilled crankshaft, force feed type oiling system, the oil ducts in the crank pins should be cleaned out with a rag or wire swab, (or better, a small wire brush) and the number one rod bearing fitted. Each of the two liner assemblies in each rod are made up of a number of shims .002 of an inch thick. These shims are bonded or sweated together, to make one mass, or known to the trade as "laminated liners." See Fig. 19. One of these shims is to be peeled from each of the two liners, and the rod assembled to crank pin with piston hanging down or to one side. See Fig. 20. Nuts are to be tightened firmly and if the correct amount of shims have been removed, the piston will be just free enough to fall of its own weight. The mechanic must be certain to remove an equal

number of shims from each liner in each rod. Next the rod should be checked for side play on the crankshaft. This side play or clearance should not be less than .004″ or more than .008″. Finally the nuts and cap are to be removed, the rods and piston reversed and inserted in the bore, the liners, cap and nuts to be loosely assembled, and work begun on the adjustment of one of the other rods. The crankshaft is next to be turned and this operation repeated on the other rods.

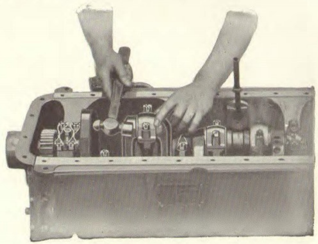

Fig. 21
Testing Rod Bearing Fit
With the rod adjustment just right, a slight snapping movement will be felt by the forefinger. A heavy blow need not be used

If through lack of time, or because the piston pins and rings are known to be in good order, the removal of the piston is not deemed necessary, the adjustment operations are as follows. The two end cranks are to be turned to the lowest points and cotters, nuts, cap and liners removed from these rods. Next, shims are to be peeled off, reassembled and tested as described below. In the same order as outlined above, the other rods are to be adjusted. The test for corrections of fit in this case is the placing of the finger, as shown in Fig. 21, and tapping of the rod back and forth with a hammer. If correct, the bearing will snap against the crank check to the extent of its longitudinal clearance and the movement will be noted and felt with the finger.

New rod bearings go to the user broached and reamed to standard size, little or no fitting being required. The rod should be checked, however, after assembling to the piston to make certain it is in proper alignment, not twisted, and that the boss at the upper end properly clears the piston pin bosses in the piston. See Fig. 30.

A fixture of some sort for this purpose is part of the equipment of service stations worthy of the name, and is one of the reasons the owner should take his motor to such a station for bearing replacement.

When it becomes necessary through burning, or excessive wear, to replace the bearing, a complete new rod is to be installed. This should be obtained from the dealer through whom the vehicle was purchased.

In this manner only can the mechanic be assured of receiving the genuine article. Under no circumstances, should the old rod be rebabbitted by a service station or specialty house doing this class of work. As explained in the opening paragraph of this chapter, the process of "spinning in" bearings is one not easily or correctly done by anyone not properly equipped. The return of the old rod, cap, bolts and nuts in good order entitles the purchaser to a liberal credit for same. In this manner the new bearings which, incidentally, include a new pin bushing in the upper end, are less costly than the price of a set of removable bushings or an inferior job done by an unauthorized shop.

Main Bearings, their Adjustment and Replacement

The main bearings of Continental engine are of two different types—the first type is of the same general construction as the connecting rods; that is, while the upper halves are separate shells, the lower halves are "spun in" into the steel forged caps. The second type is the latest Close Limit Interchangeable Bearing. We will take up the older type first.

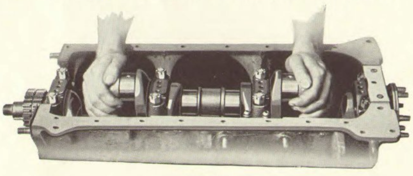

Fig. 22
Testing Main Bearing Fit
With all main bearings properly taken up, it should be possible to turn shaft when grasped as shown

Adjustments as may be necessary after long continued service consist of simply removing one or more of the .002 of an inch shims from the liner assemblies. These liners are of the same construction as those of the connecting rod and described in detail on page 26. The same number of shims should be removed from each liner assembly, making up a pair in each bearing.

As in the case of the connecting rod adjustment, a certain routine is recommended. First, all of the piston and connecting rod assemblies are to be removed. After this the mechanic should begin with the middle bearing by removing the cotter pins, nuts, cap and liners. Then, the required number of shims should be peeled off, testing each time by temporarily reassembling the liners and cap and turning the crankshaft, by grasping it by the throws, as shown in Fig. 22. It should turn smoothly, but not too freely, with one bearing properly "taken up." Following the middle bearings, the end and intermediate ones should be adjusted in the order named. After the bearings have been adjusted each is in turn to be loosened up so that the proper test may be made of the next bearing to be worked on. Finally, of course, stud nuts of all bearings are to be tightened up and "lock wired," using new wire of the same diameter as the old.

The main bearings should not be adjusted any tighter than indicated above. The total tension or friction should not be too great to prevent the operator, by considerable exertion, turning the shaft by hand as shown in Fig. 22. In fact, with both connecting rod and main bearing adjusted as instructed, it should be possible to crank the motor by hand in the usual manner. Too many mechanics believe that bearings are not properly adjusted unless so tight as to require towing the car to start. This is not correct, especially in the case of a force feed motor, which has a drilled crankshaft. The flaked off babbitt metal finds its way into these ducts, and materially affects lubrication.

When all of the adjustment provided by the liner assemblies has been used up, bearing caps should not be filed. Instead, new caps with "spun in" babbitt linings and a new set of liners should be installed. The old caps are to be returned for credit to apply against the price of new ones. As in the case of the connecting rods, the mechanic should not patronize an unauthorized source of rebabbitted bearings. Little or no fitting or hand scraping will be required except in the case of complete upper and lower replacements of all bearings, in which stock has been left for align reaming.

The complete replacement of all main bearings is a big job, and should not be undertaken by the owner or driver unless familiar with this class of work, and provided with line reaming equipment consisting of a reamer bar and adjustable reamer heads of the proper size. Detailed description of main bearing replacement is not being given, for, as stated above, the novice should not attempt the job, and the expert will in general know what is required in the way of align reaming and hand scraping to fit. The following general instructions regarding fitting are in the nature of cautions to and information for the station mechanic.

The mechanic should be certain that in complete bearing replacement, the upper halves are fitted firmly into the case bosses, also that the shim faces of the bushing are dressed off flush with the corresponding surfaces of the case boss. This is important. He should also see that there is no foreign matter between the bearing half and the case boss. Likewise he should scrape any high spots from these faces. It is of the utmost importance that the bushing be in absolute contact with its seat. After reaming or hand scraping carefully, blow out oil lines to make sure that the lines and oil holes are free from all chips and dirt.

Unlike the type of bearing previously described, the Close Limit Interchangeable Bearing requires no adjustment, for the process consists of very carefully machined bearings inside and out and the inside of the crankcase bosses which receive the bushings. This leaves a mirror-like surface accurate to within .0002 of an inch. This accuracy permits of the replacing of bearings without any align reaming, fitting or hand scraping.

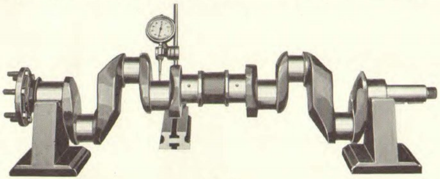

Fig. 23
Testing Crankshaft Alignment

Set up as here shown, center main bearing should not show an indicated error of more than .0015. For testing either front or rear main bearings, one of the "V" blocks is moved to the center. The same error is permissible in case of either of the two end bearings as allowed for center

Due to the manner in which the crankshaft is fitted into these Close Limit Bearings, extremely long service may be expected. Except in the case of burn-outs due to improper or insufficient lubrication, they will only need renewing when all parts have worn to such an extent that the crankshaft will require regrinding. When this stage is reached, the crankshaft is to be reground to one of the standard undersizes (.005, .010, .015 and in some cases .020). New undersize Close Limit Bearings are then installed without align reaming or hand scraping as in the case of the production jobs when first manufactured.

From the above, it will be correctly inferred that standard size Close Limit Bearings will seldom or ever be needed except to replace those which may have been damaged through boring or cutting in turn brought about by improper or insufficient lubrication.

Further attention is called to the fact that this close limit construction does not include any shims of any sort in the main bearings. The mechanic is particularly cautioned against filing the bearing caps to obtain the desired tightness of bearings. When a bearing has become worn to such an

extent that adjustment is needed, the cheaper and by all means most satisfactory method of correction will be to replace the bearing bushings.

Crankshaft

The crankshaft of the Continental engine seldom, if ever, causes trouble, due to its large diameter, special heat treatment and accurate balancing. Unless cut by dirty oil, badly burned bearings or sprung by accident, the shaft will last the lifetime of the engine with but scant attention. End play should be adjusted immediately when it becomes noticeable; not because of damage to the shaft but what might result to the front main bearing.

End thrust of the crankshaft is regulated by an adjustable thrust collar just to the rear of the crankshaft sprocket. This collar is illustrated in Fig. 24 together with a series of six .008 and eight .002 of an inch thick shims. The aggregate thickness of the shims is about .064 of an inch. This is the total allowable end wear of the front main thrust bearing. The

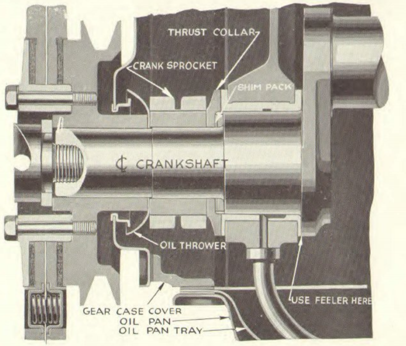

Fig. 24
Front Main Bearing Construction

This is a standard Continental design of front bearing construction. In this is incorporated thrust surfaces and means of end play adjustment minimum end play of the crankshaft is .004 and the maximum .006 of an inch. When the oil pan is off for any reason, the crankshaft should be pried to the rear. When the shaft is as far rearward as possible, the mechanic can gauge the end movement with a feeler gauge as shown.

When end play is noted, it will be necessary to remove the starting jaw nut, the spacer, if one has been used, and the damper and fan pulley, using a suitable puller. Then after the chain or gear case cover has been removed, the crankshaft sprocket or gear, as the case might be, will have to be removed also, using a suitable puller. The thrust collar can then be taken off or pushed far enough forward that the shims will be accessible. These shims are of two different thicknesses, .002" and .008", and the removal of the required number, one or more of the different thicknesses, will compensate for what wear has taken place.

If at any time the crankshaft has been taken out of the engine, or if the main bearings are for any reason being replaced, it might be well to check it for alignment. This is best done on "V" blocks and a dial indicator should be used for determining if the shaft is true. See Fig. 23. Generally, this will be found to be the case. In any event, it should not run out more than .0015 of an inch (as shown on the indicator). If the error is greater than this, the shaft must be straightened, the usual equipment for this operation being "V" blocks and an Arbor Press. .Care must be taken to use lead or copper jaws in the "V" blocks and under the screw of the press.

Main and crank pin bearings, dirt cut or worn out of round more than .0015 of an inch, should be reground to true diameter and parallelism. This work should be done by an expert grinder, if possible, and a minimum amount of metal removed where the old type of spun caps and unreamed upper shells are used. However, where the interchangeable type of bushings are used, same can be obtained in following undersizes only: (.005, .010, .015 and in some cases .020), and consequently the shaft should be reground to exactly to one of these undersizes. In emergencies, where a grinder is not availble, and where time is an important factor, a fair job can be done with one of several hand tools which are sold for this purpose. In this case only the pins can be refinished with the shaft in place. As stated above, one of these tools is to be resorted to only in an emergency, for the results are more or less make-shift.

After the shaft has been refinished by either the grinding or shaving operations described above, care is to be taken to see that the burr or sharp edge of the oil holes in each bearing is relieved. If this is not done, the babbitt surface of the bearing shells will be cut and the shavings lodged in the oil ducts and pipes. If the truing has been done with the shaft in the engine, extreme care is recommended to be certain that the steel chips have not banked up in the oil ducts or holes. This examination is of the utmost importance.

Piston Rings and Their Replacement

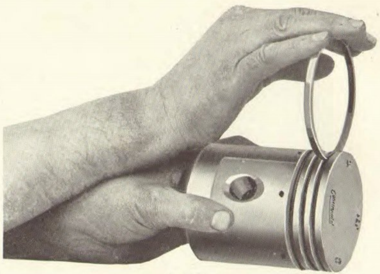

Fig. 25
Rolling Fit Test of Piston Ring
Rolling fit is used only as a preliminary test to learn if rings are of correct width for each corresponding groove

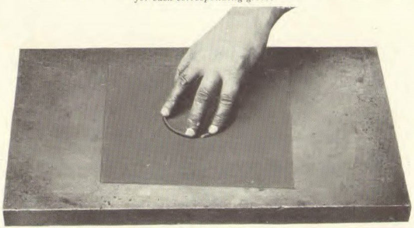

Fig. 26
Lapping Piston Ring Sides
Seldom will this lapping operation be required and only in cases where rings are slightly too large to enter ring grooves

A properly fitted piston ring, while not a large part, is probably one of the most important parts in any engine. The material in the rings and cylinder is such that under normal conditions rings should last for the longest possible time. Eventually, there will come a time when replacement is necessary. When this stage is reached only parts that have been designed by Continental for that particular model should be used.

Fig. 27
Feeler Test of Ring Fit
A final test of ring fit. The feeler should pass uniformly around the entire circumference of piston

Fig. 28
Ring End Gap Fitting
Note the use of inverted piston in cylinder bore to properly square up ring for testing. The piston is later pushed down as shown so that feeler may be inserted

New rings should be fitted to each individual bore, same being filed so that a gap of from .006 to .018 of an inch exists, the exact size of these gaps depending upon the size of the bore and the service in which the motor is being used. The method of gauging and fitting as well as holding the rings while filing is illustrated in Fig. 28. You will note in the last mentioned figure that the operator is closing the two ends together which should result in the ends of the rings being parallel. The vise jaws should be lined or covered with lead or copper to prevent mutilation of the smooth side of the rings. Also, the vise should not be screwed up more than just tight enough to hold the ring.

All rings should be true as regards width and just wide enough to be a light "rolling" fit, each in their respective grooves. See Fig. 25. If the ring is of the correct width and not "snaky," it should remain suspended in the groove. Should the ring be too wide (which will seldom be the case) it can be reduced to fit its groove by lapping on a sheet of (000) emery cloth, this emery cloth having been placed on a surface plate or other flat surface. Fig. 26. The mechanic, however, should be sure that the pressure on the ring is the same at all points. Each ring should have .0015″ clearance in its groove.

Fig. 27 shows the method of gauging with a .001 of an inch feeler ribbon. A feeler of this thickness that can be just pulled out with the thumb and forefinger will indicate an actual clearance of .0015 of an inch.

In assembling the rings, if a pair of ring pliers or similar tool is not used, the bottom ring should be assembled first. In this case the rod and piston assembly should be reversed and the lower ring slipped on over the open end of the piston. A substitute for the pliers or spreader is two strips of steel .010 or .015 of an inch thick by about one-half of an inch wide. Each strip is bent double and the two crossed as shown in the upper corner of Fig. 29. Whatever method is used, care must be taken to see that the rings are not sprung out of their natural shape and permanently distorted.

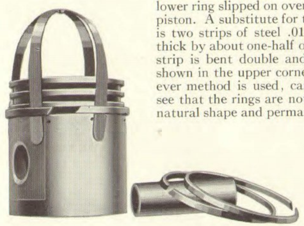

Fig. 29
Assembling Piston Rings
A convenient method of installing or removing rings. The strips of .010″ or heavier metal may or may not be riveted together in center

GENUINE CONTINENTAL rings go to the user neatly packed in cartons for protection and identification of genuineness. They can be obtained in sizes from standard to .060 of an inch oversize in steps of .005″. Always order the same oversize for the size actually needed. For example, to fit a .010 of an inch oversize bore, a .010 of an inch oversize ring should be ordered. This provides just the required amount of extra metal on the ends for file fitting. Less than this amount is not enough and more is too much to remove without affecting shape and tension of ring pressure.

Piston Pins and Bushings, Their Fitting and Replacement

There are three different methods of locking piston pins in Continental engines. Generally, in fitting piston pins to cast iron pistons, same are locked in the piston with taper point lock screws passing through both sides of the pin. The screws are locked in position and, in addition to this, two expanding lock rings are used in the pin bosses opposite each end. These rings prevent the pins coming out and scoring the walls in the event of the screws loosening up.

Generally in the case of the aluminum piston construction, only the lock rings are used, inasmuch as the pins are of the floating type, and should float to a certain extent in the pistons as well as oscillate in the connecting rod.

The third method of locking piston pins is used sometimes either with cast iron, aluminum, or alloy pistons—that is, the piston pin is locked to the connecting rod and floats in the piston bosses.

To remove the expansion lock rings, referred to above, a small screw-driver should be used as shown in Fig. 32, prying up under the raised end provided for this purpose. To replace, the tail or free end should be started first and wound or turned with a pair of flat-nosed pliers. This will compress the ring, permitting it to snap into position in its groove. The mechanic should be sure that it is expanded firmly in its seat by turning to the left.

Like the method of locking the piston pins, the fit of the piston pin into the piston is from .0002 to .0003 tighter in the case of the aluminum piston (except where pin is locked in rod and turns in piston; in this case the pin fit in the piston should be same as cast iron), than in case of the same part made of cast iron. In the case of the cast iron piston, the size of the piston pin hole should be such that the piston pin will require to be lightly driven into position as shown in Fig. 31. Its fit in the rod is not as tight as in the case of the piston. With the proper clearance the fit of the pin in the rod should be such as to support the weight of the rod when held horizontally. It is first assumed that the piston held. The slightest touch to the rod should cause it to turn on the pin.

As stated above, pins are fitted with aluminum pistons slightly tighter. After reaming the pin hole in aluminum piston to the proper size, it must

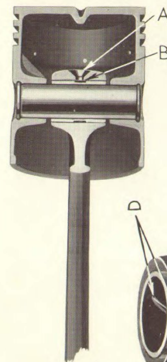

Fig. 30

Rod and Piston Assembly Sectional

Note that head of the rod is uniformly spaced between the two piston pin bosses.

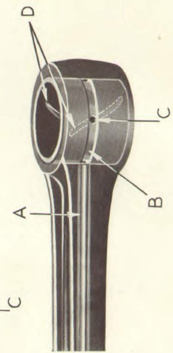

Fig. 30B

Piston Pin Lubrication System

(Full Pressure Type)

The path of the oil is from the crank pin bearing through the drilled duct "A" to the angular groove "B," thence through the radial hole "C" (one on each side) to the internal helical grooves "D"

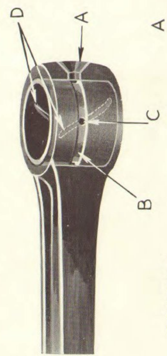

Fig. 30A

Piston Pin Lubrication System (Splash Type)

The path of the oil is from the crank pin bearing through the drilled duct "A" to the annular groove "B," thence through the radial holes "C" (one on either side) to the internal helical grooves "D"

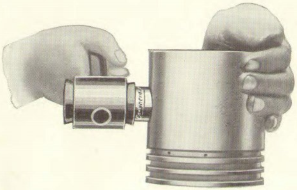

Fig. 31
Assembling Pin in Piston
It is to be noted that the fit is a light driving one

be thoroughly heated in water slightly under boiling. This causes the aluminum to expand and the pin is then pressed into position. The fit of the pin in the connecting rod in this case is the same as described above. In other words, the fit of the pin to the rod is the same whether in connection with the cast iron or aluminum piston.

Piston pins can be obtained in five oversizes, viz.: .002, .003,. 005, .010, and .015 of an inch. In making replacement the mechanic should select the oversize that will come the closest to the desired fit described above. If necessary, the pin hole in the piston boss should be reamed as well as the piston pin bushing in the end of the rod. It is presupposed, that the piston and bushing ream will have been accurately done so as to obtain smooth, true surfaces, free from minute high spots and taper bore.

A spiral expansion double piloted reamer similar to the one shown in Fig. 35 should be used. However in this case the work (rod) is held in the vise and the reamer turned.

In replacing the pin bushings in the rod units, the mechanic should be sure that the new parts of (of GENUINE make) are assembled as shown in Fig. 30.

He should also make certain that they are started squarely in the rod ends. If this is not done, the bushings will be forced out of round and be a poor fit in the rod ends. When properly installed, it will be found that there is just enough metal on the inside for reaming to standard size. Incidentally when it is found necessary to replace the bushings, standard size pins should always be fitted, if new ones are required. This permits of oversize pins being fitted later when needed.

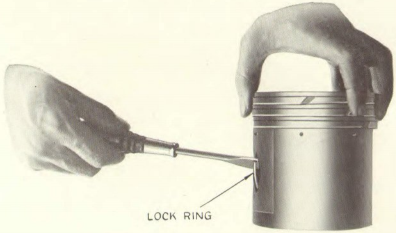

Fig. 32
Piston Pin Lock Ring Removal
Remove lock rings with small screw driver when the piston is held, open end down, on the bench as shown

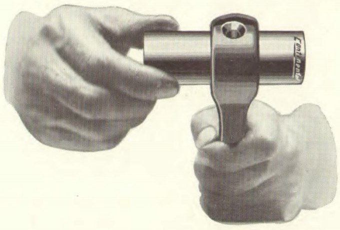

Fig. 33
Testing Fit of Pin in Rod
A properly fitted pin may be smoothly and freely turned with thumb and forefinger as here illustrated

Pistons, Their Fitting and Replacement

Like all mechanical units, being subject to wear, pistons will eventually require replacement. In addition to the standard size, they are furnished in a number of standard oversizes. To properly fit any of the above to a bore, a set of "feeler" strips is recommended. These are strips of steel about ½″ wide and about 12″ long and of the required thicknesses,—

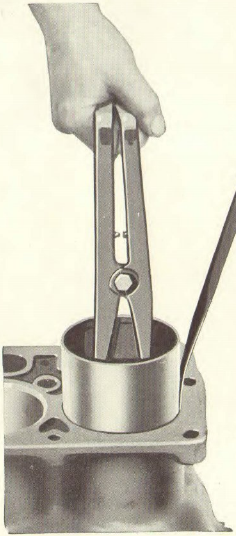

Fig. 34
Feeler Fitting Piston

The special tongs here shown are not absolutely necessary but are a decided convenience

the thicknesses of course depending upon the size of the bore and the clearances to which the pistons are to be fitted. For example, if it is desired to fit a cast iron piston to .0025″ clearance, then feelers of .002 and .003 of inch thick are needed. The use of these gauges is shown in Fig. 34.

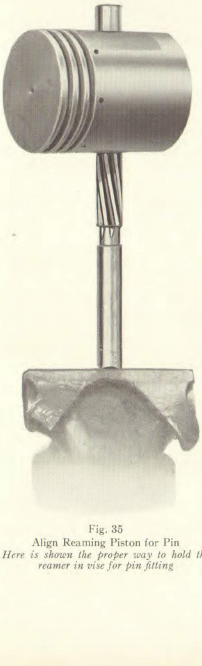

Fig. 35
Align Reaming Piston for Pin

Here is shown the proper way to hold the reamer in vise for pin fitting

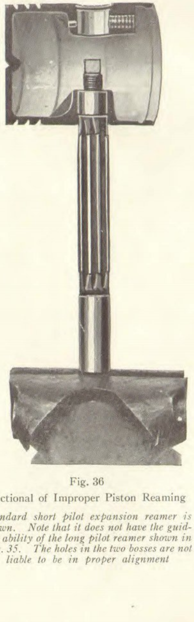

Fig. 36
Sectional of Improper Piston Reaming

Standard short pilot expansion reamer is shown. Note that it does not have the guiding ability of the long pilot reamer shown in Fig. 35. The holes in the two bosses are not liable to be in proper alignment

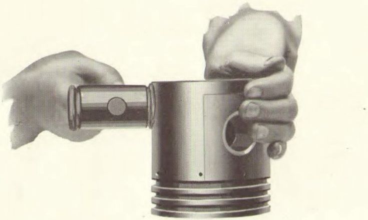

Fig. 37

Rounding Up Piston

A soft raw hide or hard rubber mallet only should be used for this purpose. Use micrometer frequently until exact trueness of within .00025 is obtained

The application of this test is the insertion of the .002″ feeler full length into the bore from the bottom. If the piston is of the correct size, it should be possible to move it the entire length of the bore freely.

With the piston as illustrated it should be possible to pull the feeler out with but little effort. Finally the test should be repeated using the .003″ feeler. In this case the piston should require considerable effort to push it into the bore, and then it should be impossible to remove the .003″ feeler with the thumb and forefinger.

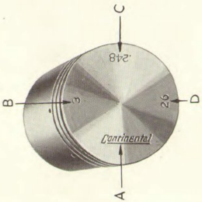

Fig. 38

Piston Head Markings

All Continental pistons are stamped as above, "A" indicating our standard trade name "B" a character which indicates the cylinder bore number (service pistons do not have this marking). "C" indicates the size of the piston. "D" indicates the weight of the piston in ounces

Where aluminum pistons are used same should be fitted .0005″ closer than the cast iron. The procedure of fitting is identical with that described above except that .0015″ feeler is used in place of .002″, and .0025″ in place of .003″ feeler.

Cast Iron Pistons should be fitted to the cylinders allowing from .00075 to .00125 clearance per inch of cylinder bore, depending upon the service for which the motor is intended. For example when fitting a piston to a 3″ bore, there should be from .00225″ to .00375″ clearance.

When fitting Aluminum Pistons in bores up to 3½″ same should be fitted one-half-thousandth closer than if cast iron pistons were being used. On the other hand, in bores of more than 3½″, the aluminum pistons should be fitted one-thousandths closer than cast iron pistons.

The bore should be tested for roundness by inserting the feeler in several positions around the cylinder walls. Any variation in roundness will be noted by an increased or decreased effort required to pull out. In making this test, it is presumed that the piston has been previously "miked" to learn if it has been knocked out of round after leaving the Continental factory. Any pistons that are not true as to diameter, can be corrected by lightly tapping with a raw hide mallet as shown in Fig. 37. Extreme care is required for this operation and a very careful examination made afterwards to determine if any cracks have resulted.

Because of the necessity of the proper fitting of piston pins it is of the utmost importance that the reaming of the pin holes in the pistons be not only of the correct diameter, but also of smooth surface and in perfect alignment. To accomplish this, the type of reamer referred to previously must be used. A glance at Fig. 36 will make clear how almost impossible it is to obtain perfect alignment by using a standard reamer. The mechanic should note what little alignment is offered by the short lead pilot.

Front End Drive

GEAR DRIVEN FRONT END—Gear sets vary in arrangement from a simple three gear layout to a six gear layout. Illustration Figs. 40 and 41. The five, and six gear front ends are generally found in larger bus and truck engines, where special gears for accessory drives are required. It will be noted from Fig. 41 that in addition to conventional camshaft, crankshaft and water pump shaft gears are added individual drives for magneto, generator and air compressor units. Idlers are interspaced to permit of smaller main gear diameters and shorter gear centers. The effort required to properly fit a set of replacement gears is increased with the addition of each gear to a train. In other words, it is obviously easier to fit up a set of three gears than a train of six or seven.

Most front end drive gears have the helical cut tooth, although there are a few of the straight or spur tooth design. Comparison may be noted

⌊2⌋- indicates that particular gear or center to be two thousandths of an inch under-size.

②- indicates that particular gear or center to be two thousandths of an inch over-size.

⌊4⌋- indicates that particular gear or center to be four thousandths of an inch unde -size.

④- indicates that particular gear or center to be four thousandths of an inch oversize.

⌊6⌋- indicates that particular gear or center to be six thousandths of an inch under-size.

⑥- indicates that particular gear or center to be six thousandths of an inch over-size.

S - indicates that that particular gear or center is exactly correct being neither over or under-size.

Fig. 39
Chart showing gear markings and what they indicate

in Figs. 40 and 41. As a rule front end gears are of the all metal construction. The exception is where the idler or cam gear is made of some non-metallic or composition material. These composition gears usually are of two designs, one where the entire gear is made from the composition fibrous material while the other the fibrous material is enclosed with steel shrouds which form the front and back side of the gear. A few have metal hubs, but this is the exception.

Where a composition gear is not used in the train, the set is usually one of two types—soft, that is unhardened steel, semi-cast steel, or dense cast iron and sometimes the idler is of forged aluminum. The other type is hard, or a hardened and ground steel. Occasionally alloy—heat treated steel—only is used.

As a rule gears, except where composition idler or cam have been used, rarely require replacement for many thousands of miles of service, and even in the exception the composition gear is usually long lived.

Generally, in an all-metallic train all of the gears in the train must be replaced at one time. On the other hand, where a composition gear is a part of the drive, it will be sometimes necessary to change but this one gear. This is particularly true where such a gear functions as an idler or intermediate gear.

Where the entire train is to be replaced, new gears of exactly the same size as the replaced parts should be used, unless at sometime previous, new

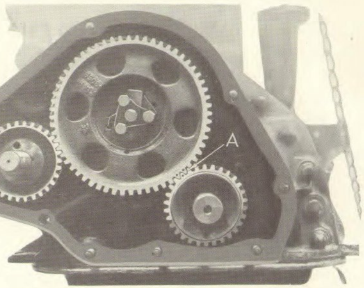

Fig. 40
Three Gear Front End Train

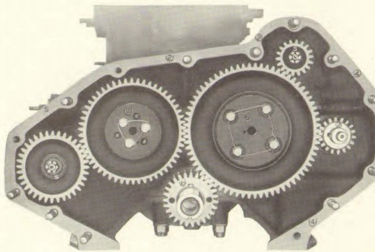

Fig. 41
Six Gear Front End Train

bushings have been installed in the crank case which would affect the gear centers. In the case where a single gear is replaced, the new one should be slightly larger to compensate for the slight wear on the teeth of the other gears. All Continental gears are stamped on the hub or rim of each gear indicating the size of the gear. In addition the gear case flanges are stamped to show the actual gear centers, indicating the amount if center is over or under (when not standard) the theoretical gear center dimension. (See charts Fig. 39). The difference lies in that when such markings appear on the gears the latter are just so much over or under (or standard) in the pitch radius (not pitch diameter) and have but a comparative relationship to the actual "back lash" as measured by feelers between the tooth bearing surfaces. The latter method of "feeler fitting" is used only when sizes are not indicated and is not considered as accurate as the pitch radius.

All metal gears of the soft variety are to be fitted "metal to metal" with no perceptible back lash. If of the hardened and ground type, an angular tooth "back lash" of .001″ should exist. It is obvious of course that the softer gear will slightly wear or "run in" after a short operation period where the hardened metal will wear but little after considerable usage. Composition gears are to be fitted as closely as a soft metal, and in the case of an idler about .001″ tight.

In engines where the camshaft gear is bolted to the flange of the camshaft, it will be noted that one of the bolts or screw holes is offset approximately $\frac{1}{16}$″ which insures that the gear will be properly assembled with relation to the cams. If this point is kept in mind and the gear is turned on the shaft until the holes exactly line up, the installation will be greatly simplified.

CHAIN DRIVE FRONT ENDS vary from two sprockets to six, the latter being generally found in the larger type engines which are used in bus work where special accessory drives are required. It will be noted that Figure 43 illustrates the type that is manually adjusted to compensate for wear. On the other hand Figs. 44 and 45 illustrate the construction employing automatic take-up sprockets. In other words the spring actuated idler sprockets automatically compensate for any wear to the chain or the sprockets to a point of course where the chain is entirely worn out. See Fig. 44 illustrating method of adjusting when installing new chain.

As a rule chain front end drives require slightly more attention while in operation than do gears, and are somewhat shorter lived. On the other hand they are easily replaced since little if any attention need be paid to the sprocket centers or the face of the sprockets. As a rule the sprockets never have to be replaced.

On the manual adjusted front end drive, an initial adjustment is recommended to compensate for the initial wear of the new teeth after the chain

has seen from 500 to 800 miles' service. This adjustment at this time is necessitated by the wearing off of minute high spots of the sprocket and chain tooth contact surfaces.

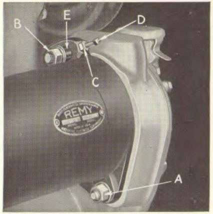

Fig. 42
Showing point of adjustment

Regardless of mileage, the chain should be adjusted when either "whining" because of being too tight or "slapping or rattling" because of being too loose. A simple test to determine if too loose is to attempt to turn one of the accessory shafts. If excessive movement is perceptible it is too loose.

This condition can be corrected by loosening the lock nuts as shown at points A and B, Fig. 42, by using a small bar to force the generator, or generator support as the case might be, away from the motor until a slight hum or whine is introduced. Then back off the tension or slacken until this noise disappears. Great care must then be exercised to make sure that the lock nuts are securely fastened.

When the full amount of adjustment has been used, the chain must be removed and either shortened or replaced. Shorting can be accomplished by removing the half or hunting link provided for this purpose. After the removal the two ends of the chain must be securely re-riveted together. When after such shortening the chain has again been used to the fullest extent of the adjustment, it should be replaced. Under no circumstances should further shortening be attempted. After this amount of wear, it might also be advisable to replace the sprockets. This is because the tooth forms will have been changed to such an extent that the chain will tend to climb.

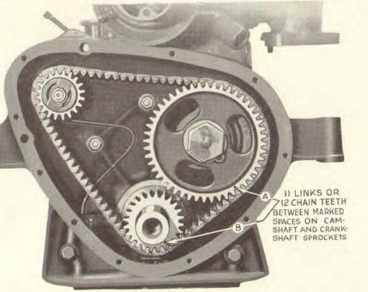

Fig. 43
Three Sprocket Front End
Note timing marks as indicated at "A" and "B." In disassembling do not re-mark. Use factory stamping

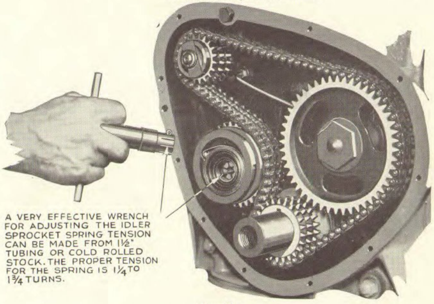

Fig. 44
4-sprocket front end showing method of tightening spring in idler sprocket

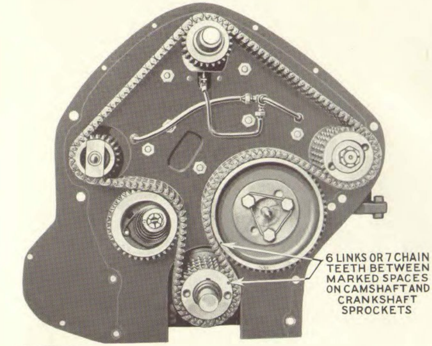

Fig. 45
R Series Type—Six Sprocket—Front End

Camshaft and Bearings

The alloy steel camshaft used in the Red Seal engine seldom is of itself the cause of any trouble. All of the bearings and cam faces are almost glass hard and ground to a mirror-like surface. Such a condition resists natural wear to almost an unbelievable degree. Bearings of the shaft will always outlive any other part of the engine, while the cams, unless cut by too close tappet adjustment will last equally long. Unless sprung while out of the engine assembly, the shaft, as a whole, will always remain in perfect alignment. All of these statements are based on the supposition that sufficient and suitable lubrication is provided.

Where one or more of the cams have been cut by too close tappet adjustment (See Fig. 6), it can, if not too badly scored, be reconditioned by honing. Care must be taken to hold the hone squarely on the face and the movement should be in the direction of rotation. Cams as a rule cannot be reground, without affecting the operation of the engine, and certainly, this cannot be done outside of the Continental shops. If in doubt as to the salvage value of a camshaft, it should be forwarded for inspection to the "Claim Department of the Continental Motors Corp'n." at either the Detroit, Michigan, or Muskegon, Michigan, plant, depending of course on which plant the motor is serviced.

While the majority of Continental camshafts operate in babbitt lined bushings, in a few models this is not the case as the shafts operate in cast iron supports. In these cases oversize shafts of several sizes are furnished to take care of any wear that might take place. When, through lack of lubrication (the usual cause), or natural wear, the camshaft bushings in the crankcase, or the cast iron supports in the case of the motors which do not have the babbitt bushings, become enlarged enough to cause a knock, then either an oversize shaft must be installed or else the bushings replaced. This is a job equal in importance, and care required, to that of the main bearing replacement. It is an operation not to be undertaken by the layman, nor the expert either, unless provided with the necessary align reaming equipment. It is utterly impossible to hand scrape a set of camshaft bushings. They must be align reamed.

In the case of the babbitt lined bushings, care is to be exercised in driving the old bushings out and the new ones in. This precaution is to be taken in order to avoid springing or mutilating the case web in one instance and the protection of the new bushing in the latter. In reassembling, use a fibre or hardwood block. Strict attention should be paid to the alignment of the oil holes in the case and new bushings. The latter is to be redrilled, if necessary, after assembling so that the hole in the bushings will register with the corresponding holes in the case bosses.

Water Pump and Associate Parts

With but few exceptions the Continental engine is equipped with centrifugally circulating pump. In the case of the exception the thermo-syphon system is employed. The water pumps are located at three different points. FIRST, ON THE SIDE AT THE FRONT END OF THE MOTOR—In this case the pump is driven by a gear which runs in the front end train. Figure 48 illustrates this type of pump as well as the point for adjusting the end play. To adjust the end play, the same procedure is to be followed as in the case of the crankshaft described on page 31.

SECOND, ON THE SIDE NEAR THE REAR OF THE MOTOR—In this case no end play adjustment is provided since adjustment is not necessary, the pump being driven by a flexible coupling from either the generator or one of the other accessory units. See Fig. 46.

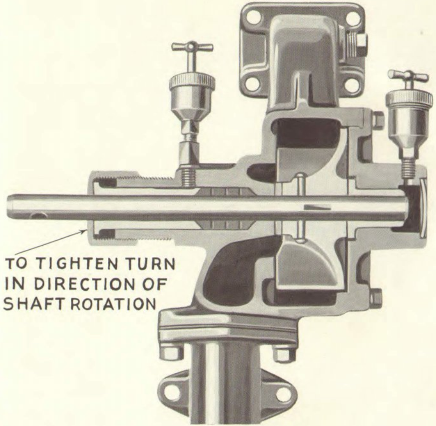

Fig. 46
Water Pump Sectional

THIRD, IN THE WATER JACKET OF THE BLOCK, OR IN THE WATER JACKET ON TOP OF THE HEAD AT THE FRONT END OF THE MOTOR, which of course is above the chain case. The one shaft driven by a "V" belt serves to drive both the water pump and the fan. (See Fig. 47).

Fan belt adjustment is provided for through a movable sleeve on the front of the fan pulley. By loosening the set screw as illustrated and turning the front half to the right the width of the "V" in which the belt rides

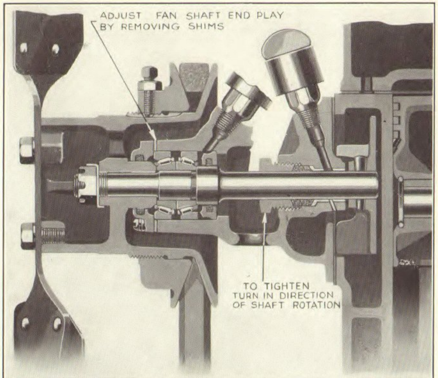

Fig. 47

Water Pump Sectional

is narrowed causing the belt to ride the outer diameter. This in effect shortens the belt and tightens it to the proper tension. Except for an occasional turn or part turn of the packing nuts and lubrication through grease cups (see discussion under heading "Lubrication"), water pumps require practically no attention.

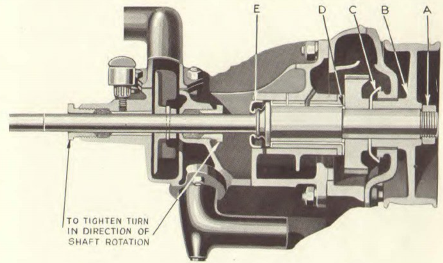

Fig. 48

Water Pump Sectional

Removal of sufficient number of shims "D" will compensate for endwise wear. Make certain that nut "A" is drawn up tightly, so as to force pulley "B," oil thrower "C" and the gear tightly against "A" shim pack "D"

Flywheel

The semi-steel flywheel of the Red Seal engine is attached to the crankshaft flange with six bolts. One of these is offset $\frac{1}{16}''$. This is so arranged that with a correspondingly located hole in the shaft flange that the flywheel can be assembled in but one position with regard to the number one and number six crank pins. Seldom will the flywheel require replacing unless due to the teeth being broken out. The length of the usage will depend upon how the engine is started as explained later.

If the ignition lever is not retarded, each time the engine is started there is a decided probability that one or more of the teeth in the flywheel rim will be chipped or broken. This condition will generally be noted in three equally spaced positions on the wheel. This may even result in extreme cases where the teeth are completely broken out. There is but one way to eliminate the possibility of this chipping and breaking and that is to retard (where a manual type of ignition system is used) the "spark" every time when starting the engine.

About the only precaution to be exercised when replacing an old wheel or installing a new one is to make certain that it is truly bolted to the crankshaft flange. When finally secured to the shaft, the flange or rim of

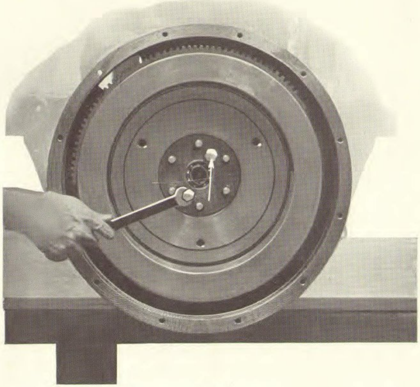

Fig. 49

Removal of Flywheel

Two cap screws as shown should be used to remove flywheel if the latter is very tight on its flange

the wheel should run within .006 of an inch of being true. This condition can best be noted by clamping a dial indicator to the flywheel housing as shown in Fig. 50. If not within limits specified, the wheel must be taken off and any chips or foreign matter on the flange face or recess of wheel removed. Flywheel bolts are provided with lock washers and the nuts should be set up very tightly against these. It will be noticed that the wheel is provided with two tapped holes for pulling or removing from shaft. Cap screws threaded 2″ long or longer should be used as shown in Fig. 49.

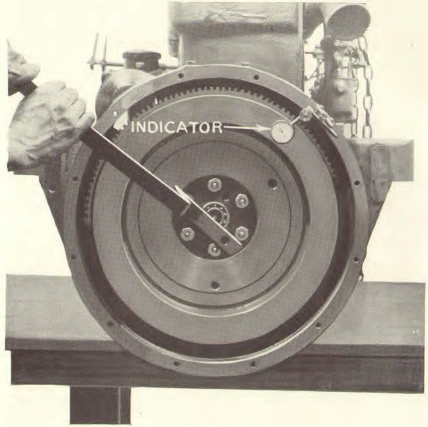

Fig. 50

Testing Trueness of Flywheel Rim

In making this test see that indicator support is as short as possible to eliminate possibility of vibration error

Lubrication

The lubricating system is one of the most important features of the present day engine. Upon its proper functioning depends the successful operation of the vehicle as a whole.

The lubricating system of all Continental Red Seal Engines has been worked out to meet the requirements of each model.

All of the later systems are adaptions of force feed, spray, constant pressure types. The oil is drawn through a screened inlet, from the sump or oil pan by the pump. From the pump it is forced either through a gallery line or distributing manifold cast in the side of the crankcase or through a main header located underneath the main bearings. The oil is forced into the main bearings from this header. From the main bearings it is fed through ducts or passages drilled in the crank throws to each of the connecting rod big end bearings. The piston pins receive their lubrication by oil which is thrown off the crank pins and main bearings into the top of the pistons then dripping down into the large opening at the top of the rod from which place it is fed through the angular groove into the pin bearing proper or else through rifle drilled connecting rods. See Figs. 30A and 30B.

The camshaft bearings are usually supplied with oil which is fed through ducts drilled from the nearest main bearing. In some cases the supply is through a rifle drilled camshaft. It is noted here that all major bearings are under pressure feed. The front end drives, either gear or chain and sprockets are lubricated from oil which is fed under pressure from a line leading from the main header. It is further augmented by heavy vapor or spray drawn into the front end compartment through the bottom.

Proper lubrication is one of the most important conditions to be given attention, and this is not only true in regard to the brand of oil, but also the grade of oil used, and the regularity with which the old oil is drained off and replaced with fresh. Even this operation can be done correctly or otherwise.

Under the widely varying types of service to which the Continental Engines are subjected, no fixed recommendation can be given to meet all operating conditions. As a result of a thorough survey of the variable service encountered, load conditions are classified in two groups. The first includes those for which the engine is required to supply, in regular service, less than 50% of the engine's maximum power and second comprises those which normally require more than 50% of the engine capacity.

For example, consider the following service on trucks as coming under heavy duty service:

(a) Trucks hauling loads greater than their normal rated capacity.

(b) Trucks used for hauling trailers.

(c) High speed of truck in M.P.H. over long periods.

(d) High operating speed of engine R.P.M. when working through multiple speed transmission.

With the different types of service, then classified loads as Light Duty and Heavy Duty service, recommendations are made to satisfy this condition.

The recommended oil body for the two types of service (using the S.A.E. Viscosity numbers) is shown in the chart which follows. The S.A.E. numbers are not necessarily indicative of a high grade oil and it is suggested that the lubricants of the most reputable oil refiners be used.

We suggest that the charts of recommendations as issued by the most reputable oil refiners be followed, especially charts having light and heavy service recommendations.

	Light Duty		Heavy Duty	
Models	Summer	Winter	Summer	Winter
B5, B7	30	30	40	30
K4, L4	30	30	40	30
2P, 8R	30	30	40	30
S4, S10	30	30	40	30
9T	30	30	40	30
6B, 8B	30	20	40	30
14C, 16C	30	20	40	30
11E, 16E, 18E	30	20	40	30
8F, 9F	30	20	40	30
H8, H9	30	20	40	30
15H, 16H, 28H	30	20	40	30
12K, 15L, M4	30	20	40	30
14R, 15R, 16R, 18R, 20R	30	20	40	30
21R, 29R, 30R, 31R, 32R	30	20	40	30
S5, S11, S12	30	20	40	30
15S, 16S, 17S	30	20	40	30
11U, 15U	30	20	40	30
W5, W9	30	20	40	30
Y2	20	20	40	30
H2	30	20	30	30
14K	30	20	40	20
16Z, 17Z, 18Z	..	..	50	30
H15, H16, H21, H22, H23	30	30	50	30
H24, H25, H26, H27, H28	30	30	50	30

When water is condensed in the lubricating oil, and where the gasoline has a high sulphur content, it is possible for a small amount of sulphuric-acid to form in the crankcase. This will corrode the hotter parts of the engine, such as piston pins.

Avoid the use of poor fuels which contain excessive sulphur, and prevent the condensation of water vapor by keeping the engine hot. A thermostat or radiator cover will help to maintain a good operating temperature.

The oil should be drained and replaced every 500 miles. The draining should be complete and the interior of the engine washed out with one quart of a cheaper grade of oil before refilling with the proper quantity of high grade motor oil that is regularly to be used.

Each oiling system includes a pressure regulator which is properly set when the engine leaves our plant. However, after considerable service the pressure will tend to slightly decrease. This pressure can then be stepped up by an adjustment of the regulator. It is not necessary to carry the pressure any higher than as originally recommended since it only imposes a greater load and corresponding wear on the gears driving the oil pump. Anything much less than the recommended pressure will not be enough to afford proper lubrication.

The height of the oil in the reservoir or pan is indicated by either a dial float gauge or by a bayonet or stick type gauge. In each case, the gauge is conveniently located. At no time should the minimum level be permitted to reach a point lower than the half way mark nor should the maximum oil height be higher than the "full" mark.

The oil pan tray and its screens should be removed once every six months and thoroughly cleaned. This is to make certain that the screens and oil passages are free from sediment, dirt and other foreign matter. There is a certain amount of lint and other matter which adheres to the sides of the pan, the tray and particularly the screens, that will not wash away when the periodical oil change referred to above is made. This is the reason for recommending the removal of the pan.

Oil dilution and thinning out can be reduced to a minimum by the proper adjustment of the carburetor to furnish as lean a mixture as possible, also by operating the motor at a fairly high temperature and finally by making certain that the vacuum tank float does not leak. This latter condition is apt to cause the fuel level in the vacuum tank to become higher than normal and to permit of more or less raw fuel being drawn into the intake manifold.

Briefly summed up the results of improper lubrication are:

Hard starting.

Premature piston wear.

Premature cylinder wear.

Short lived main and connecting rod bearings.

Excessive gasoline consumption.

Smoking due to abnormal increase of oil level on account of oil being diluted with gasoline.

Etching or corrosion of piston pins and tappet faces.

Excessive carbon in cylinders.

Tendency to overheat.

Very little or no compression.

All of the above result in lack of power and poor performance.

Summary

All of the previous statements and instructions have been largely in the nature of advice as to the adjustment and replacement of certain parts. The necessity of making these repairs will be delayed for an indefinite period, if the engine is given the proper attention in the way of not overloading and of oil draining and cleaning. With this thought in mind, there is being appended below a list of the cautions to be heeded. These are:

Excessive use of choker is to be avoided.

After starting, the engine should be given time to warm up before load is applied in the way of driving the vehicle or machine it is to operate.

The carburetor must be kept properly adjusted. As thin a mixture as will give sufficient amount of power should be supplied at all times. A too rich mixture causes incomplete burning of the fuel as mentioned previously in this manual.

Idling for long periods should be avoided, likewise excessively slow driving for long distances.

The motor should not be permitted to become overheated. Most vehicles and equipment using a Continental engine either are or should be equipped with a temperature indicator of some sort. The engine should not be operated at any time when this gauge indicates a higher temperature than "danger."

During the winter the radiator and hood louvre should be covered to allow the engine to warm up rapidly and to operate, while under load, at a temperature approximating that of summer.

The crankcase should not be flushed with kerosene. It is impossible to drain all of the pockets and various places in which this flushing medium will be trapped. That which remains dilutes the fresh oil. The engine is to be drained when warm, and the oil agitated. This will permit of almost all of the sediment being carried off. The draining is to be done as often as specified elsewhere in this manual.

The oil pan is to be filled to the proper level daily, but should not be overfilled. This is liable to cause oil pumping with its attendant evils.

Examination should be made periodically to observe whether or not the brakes are dragging or any other abnormal retarding action exists. This applies, in the case of a road vehicle, to tires which are too soft or misaligned wheels.

Trouble Chart

The following is a diagramatic trouble chart or table to be consulted in the case of any trouble or apparently abnormal condition becoming evident.

Engine Hard to Start

Irregular Firing	Defective Magneto Wire from Magneto or distributor off or loose Spark plug fouled, broken or cracked Switch not turned on Points of spark plug more or less than $\frac{1}{32}''$ Dirt, water or oil on magneto or distributor contacts Ignition system damp Improper timing Valve tappets improperly adjusted Intake manifold leaking air Improper mixture
Faulty Carburetion	Float valve sticking Gaskets leaking Fuel tank empty Valve leaking Intake manifold leaking
Poor Compression	Inlet or exhaust valves not seated Inlet or exhaust valves stems warped or gummed Piston ring stuck in piston groove Cylinder head gasket leaking Cracked, broken or loose spark plugs Worn pistons and cylinders

Engine Stops or Misses Explosion

Fuel Feed Irregular	Valves or tappets sticking Water in carburetor Spark plugs fouled or cracked Fuel throttled too closely Cylinder head gaskets leaking Manifold gaskets leaking Mixture too lean—back firing Mixture too rich—missing

Engine Uses too Much Fuel

Mixture too rich
Spark too late
Valves leaking
Engine improperly lubricated

Loss of Power

Poor Compression	See Compression under "Engine Hard to Start"
Poor Lubrication	Oil level too low Insufficient feed of oil Inferior grade of oil
Carburetor or Mixture Wrong	Float valve sticking open Valves leaking Intake manifold leaking air Gaskets leaking Carburetor improperly adjusted Mixture too rich Mixture too lean
Engine Overheated	Cooling water low or dirty Cooling system stopped up Loose fan belt Pump or fan not running Poor lubrication Mixture too rich Spark retarded too far

Explosion in Muffler

Irregular or weak spark
Exhaust valve stays open
Exhaust valves warped
Carbon on exhaust valve seat

Excessive Smoke

Blue Smoke	Too much oil in crankcase Oil of incorrect body
Black Smoke	Float sticking or leaking

Engine Knocking

Spark advanced too far
Fuel mixture too lean
Engine overheated or overloaded
Insufficient lubrication
Carbon accumulation in cylinders
Engine loose on frame or foundation
Wrist pin or connecting rod bearing loose

Explosion in Carburetor or Manifold

Gas mixture too weak
Intake valves sticking
Weak spring or warped intake valve
Manifold loose or leaking
Intake tappets set too close

Should the operator, owner or garage man require any advice not covered in detail in the previous pages, it is suggested that he write to the Service Department of the manufacturer of the vehicle or equipment in which his engine is installed. The Continental Service Department is pleased at all times to answer such inquiries as just referred to, but most vehicle manufacturers much prefer to handle these matters direct.