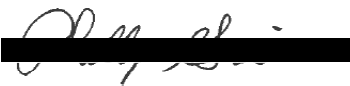




Continental Motors

ENGINE EXAMINATION REPORT

ENGINE MODEL	C90-8F
ENGINE SERIAL NUMBER	42098-9-8
AIRCRAFT MAKE & MODEL	Piper J3C-65
AIRCRAFT SERIAL NUMBER	18763
AIRCRAFT REGISTRATION	N98550
FILE NUMBER	17-112

NAME	SIGNATURE	DATE
Phillip Grice		11/01/2017

ENGINE EXAMINATION REPORT**FILE NUMBER:**

17-112

ENGINE S/N:

42098-9-8

PAGE 2 of 6**GENERAL INFORMATION**

EXAMINATION		ACCIDENT DATA	
DATE	10/19/2017	NTSB ACCIDENT #	ERA17LA275
FACILITY	Continental Motors	NTSB INVESTIGATOR	Robert Gretz
ADDRESS	2039 South Broad Street Mobile, Alabama 36615	FAA INVESTIGATOR	William DeKine
		ACCIDENT DATE	08/13/2017
		ACCIDENT LOCATION	Salisbury, CT

ENGINE INFORMATION

ENGINE POSITION	Single-Engine
TOTAL TIME	2,084 (at time of last annual inspection)
TIME SOH	1,006 (see Significant Logbook Information below)
TYPE & TIME SLI	Annual inspection dated July 13, 2017
BUILD DATE	08/19/1949
IN SERVICE DATE	Unknown

Significant Logbook Information:

Review of the maintenance records for the accident airplane revealed that the engine records were lost prior to 1994. An entry from June 1994 indicated that the engine was overhauled at an estimated total time of 1,300 hours and a tachometer time of 221.5 hours. During the 1994 overhaul, a "new" crankshaft and bearing set were installed as were "new" crankshaft gear bolts. In October 2013 at a time since overhaul of 689 hours, the engine was disassembled and inspected after the aircraft was involved in a previous accident (see NTSB accident number ERA11LA379 for more details regarding the prior event). According to the December 2013 maintenance entry, the crankshaft was replaced per the "Continental Overhaul Manual dated 1-1994". The engine then underwent a series of annual inspections, the last of which was dated July 13, 2017 at an engine total time of 2,084 hours and a listed time since major overhaul of 317 hours. It should be noted that the 2013 disassembly, repair, and rebuild was not endorsed by the signer as an overhaul; therefore, the time since major overhaul listed on the annual inspections that followed were in error.

Report Summary:

Search Code(s):

13-09-04, 13-11-03, 13-26-03

The crankshaft gear bolts were fractured and the crankshaft gear was separated from the crankshaft. The gear was deformed and fractured. The crankshaft gear contained an oil stain witness mark in an area that coincided with a dowel pin hole on the crankshaft. However, the gear/crankshaft did not contain a dowel pin as specified in the most current version of the illustrated parts catalog (IPC) and the overhaul manual (OM).

Disposition of engine following exam:

The engine was returned to Anglin Aircraft Recovery Services, LLC at the request of the owner's representative.

ENGINE EXAMINATION REPORT**FILE NUMBER:**

17-112

ENGINE S/N:

42098-9-8

PAGE 3 of 6**INSPECTION WITNESSES**

NAME	John Kent	NAME	Lisa Jersild
ADDRESS	Mobile, Alabama	ADDRESS	Mobile, Alabama
ORGANIZATION	Continental Motors	ORGANIZATION	Continental Motors
PHONE		PHONE	
NAME	Greg Eastburn	NAME	Leah Read
ADDRESS	Mobile, Alabama	ADDRESS	New Hampshire
ORGANIZATION	Continental Motors	ORGANIZATION	NTSB – Eastern Region
PHONE		PHONE	
NAME	Phillip Grice	NAME	
ADDRESS	Mobile, Alabama	ADDRESS	
ORGANIZATION	Continental Motors	ORGANIZATION	
PHONE		PHONE	

EXTERNAL ENGINE CONDITION

External examination of the engine did not reveal any anomalies. The engine was placed on an examination stand for disassembly.



ENGINE EXAMINATION REPORT

FILE NUMBER:

17-112

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42098-9-8

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ENGINE EXAMINATION REPORT

FILE NUMBER:

17-112

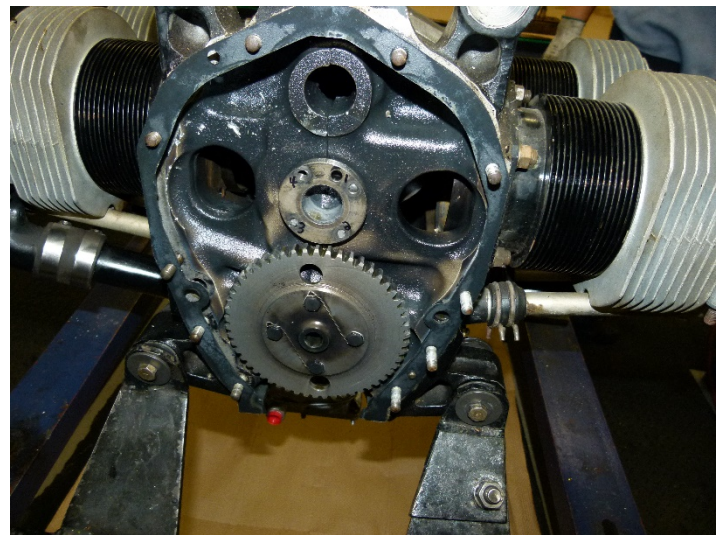
ENGINE S/N:

42098-9-8

PAGE 5 of 6

ENGINE EXAMINATION SUMMARY

Disassembly of the engine revealed that the crankshaft gear was fractured and separated from the crankshaft. The four crankshaft gear screws that retain the gear to the crankshaft were fractured and the safety-wire remained intact and in place. Normally, the gear is piloted on the aft end of the crankshaft and aligned by a dowel pin, and the gear is retained by the four screws. However, the dowel was not present as the gear that was installed on the crankshaft did not have a dowel hole. The dowel hole was present on the crankshaft and it left a witness mark on the gear. The IPC and OM that were current at the time of the last overhaul and the last disassembly/repair specify a crankshaft and a gear that utilize a dowel pin (see OM and IPC excerpts attached at the end of this report). **NOTE:** The red arrows in the photos below indicate either the dowel pin hole on the crankshaft or the dowel pin hole witness mark on the gear.



ENGINE EXAMINATION REPORT			
FILE NUMBER:	17-112	ENGINE S/N:	42098-9-8
		PAGE 6 of 6	

**Continental Motors C90
IPC and OM Excerpts**



AIRCRAFT ENGINE ILLUSTRATED PARTS CATALOG

This illustrated parts catalog is provided as a reference for non-production Continental Motors aircraft engines. Part numbers cited in this catalog may have been superseded by a later part number.

1. Locate the figure representing your installed engine specification to determine the part number(s) required.
2. Contact an authorized Continental Motors Parts Distributor or Continental Motors Customer Service to check the part number supersedure history.

This catalog applies only to the engine model specifications listed below. For all other engine models, refer to <http://continentalmotors.aero>.

C-75 ALL	O200A8	O200A17	O200A27	O200A36	O200A45	O200A68
C-85 ALL	O200A9	O200A19	O200A28	O200A37	O200A46	O200A77
C-90 ALL	O200A10	O200A20	O200A29	O200A38	O200A47	O200A78
O200A1	O200A11	O200A21	O200A30	O200A39	O200A52	O200A79
O200A2	O200A12	O200A22	O200A31	O200A40	O200A54	O200A84
O200A4	O200A13	O200A23	O200A32	O200A41	O200A57	O200A85
O200A5	O200A14	O200A24	O200A33	O200A42	O200A59	O200B1
O200A6	O200A15	O200A25	O200A34	O200A43	O200A62	O200B8
O200A7	O200A16	O200A26	O200A35	O200A44	O200A63	O200B9
						O200C ALL

FOR REFERENCE ONLY

CURRENT STATUS OF PAGES AS OF: AUGUST 2011

This catalog has been edited to mask or remove information pertaining to current production engines. The remaining information, applicable to non-production engines, is untouched and identical to the original information, dated June 1984.

MODELS: C75, C85, C90 & 0200A, B & C Series

PARTS CATALOG X30011

PAGE	STATUS	PAGE	STATUS	PAGE	STATUS	PAGE	STATUS
Cover	2						
ii	2						
iii thru iv	0						
1-1 thru 1-3	0						
1-4 Blank added	1						
2-1 thru 2-29	0						
2-30 Blank added	1						
3-1 thru 3-2	0						
4-1	0						
4-2 Blank added	1						
5-1 thru 5-4	0						
6-1 thru 6-6	0						

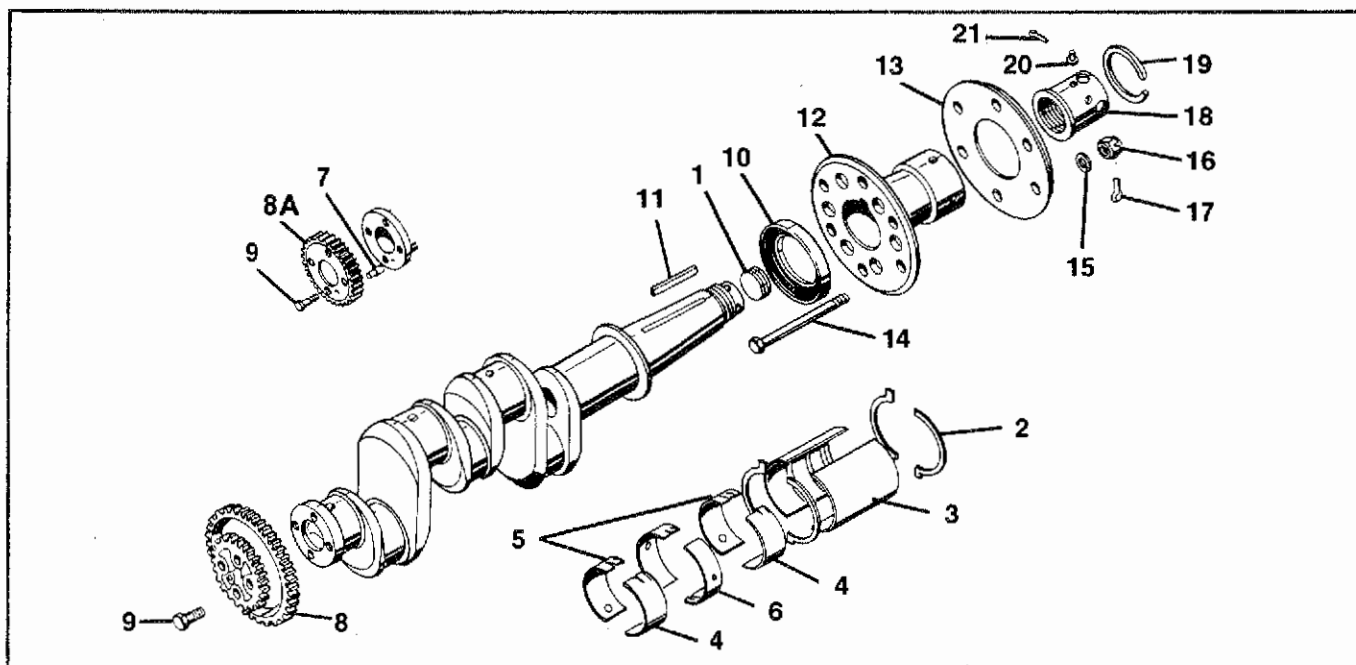


FIGURE 4. CRANKSHAFT ASSEMBLY - TAPERED.

FIG. INDEX	PART NUMBER	1	2	3	4	5	DESCRIPTION	C 7 5	C 8 5	C 9 0	0 2 0 0 A	0 2 0 0 B
4-	530196A1						② Crankshaft Assembly	1	1			
- 1	500398						. Plug	1	1			
- 2	633141						① Washer, Thrust	4	4			
- 3	530058						† ① Bearing, Front	4	4			
- 4	633398						† ① Bearing, Main Cylinder 1 & 3	2	2			
- 5	643233						† ① Bearing, Main Cylinder 2 & 4	2	2			
- 6	639640						† Bearing, Connecting Rod	8	8			
- 7	630651						† Dowel	1	1			
- 8	35016						Gear Cluster, Crankshaft (-12)	1	1			
- 8A	530641						Gear, Cluster, Crankshaft (-8)	1	1			
							ATTACHING PARTS					
- 9	21346						Screw, 1/4 - 28 x 7/16 Inch Long	4	4			
- 9	22532						Screw, 1/4 - 28 x 1 Inch Long	4	4			
							* * * *					
-10	24321						Seal, Crankshaft, Oil	1	1			
-11	500400						Key, Propeller Hub	1	1			
	A3746						Hub Assembly	1	1			
-12	3745						. Hub	1	1			
-13	3991						. Flange	1	1			
-14	21468						. Bolt	6	6			
-15	2474						. Washer, Plain 3/8 Inch	6	6			
-16	2458						. Nut, Castle 3/8 Inch	6	6			
-17	2506						. Pin, Cotter	6	6			
-18	21202						. Nut, Propeller Hub	1	1			
-19	21203						. Ring, Propeller Hub	1	1			
-20	AN392-11						. Pin, Flat Head	1	1			
-21	2500						. Pin, Cotter	1	1			

NOTES: --

- ① See Section IV for all engine bearing kits, including sets for crankcases with dowels installed in front bearing boss and sets with dowel in thrust washer.
- ② For Models without the letter "F" stamped after the model number (Example: C75-8).

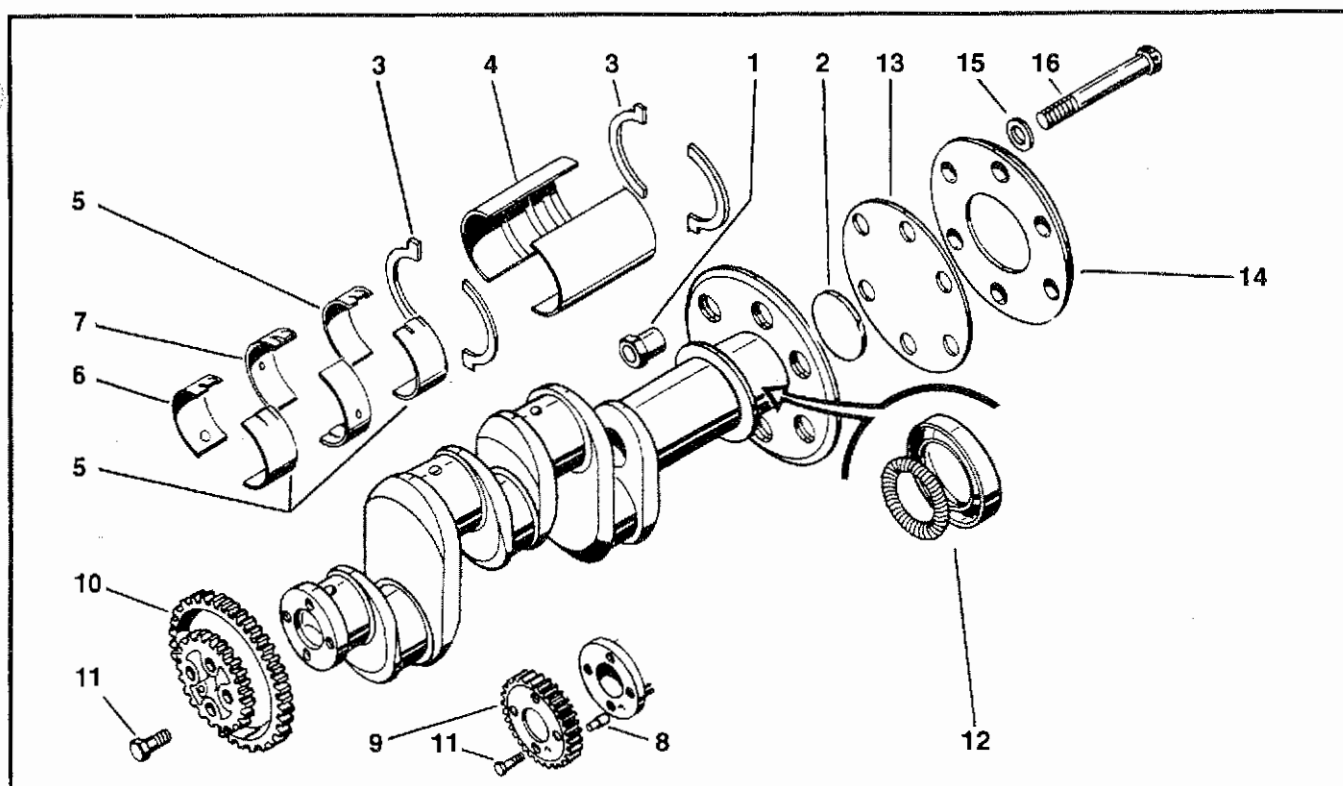


FIGURE 5. CRANKSHAFT ASSEMBLY - FLANGED.

FIG. INDEX	PART NUMBER	DESCRIPTION	C 7 5	C 8 5	C 9 0	O 2 0 0 A	O 2 0 0 B
5-	530199A1	④ Crankshaft Assembly	1	1			
	530182	Crankshaft Assembly			1	1	
	531434	Crankshaft Assembly				1	1
- 1	24769	. Bushing, Prop Bolt	6	6	6	6	6
- 2	24770	. Plug, Hubbard	1	1			
- 3	633141	① Washer, Thrust	4	4	4	4	4
- 4	530058	† ① Bearing, Front	2	2	2	2	2
- 5	633398	† ① Bearing, Main Cylinder 1 & 3	2	2	2	2	2
- 6	643233	† ① Bearing, Main Cylinder 2 & 4	2	2	2	2	2
- 7	639640	† Bearing, Connecting Rod	8	8	8	8	8
			1	1	1	1	1
			1	1	1	1	1
-10	35016	③ Gear, Cluster, Crankshaft	1	1	1	1	1
		ATTACHING PARTS					
-11	21346	② Screw	4	4	4	4	4
-11	22532	③ Screw	4	4	4	4	4
		* * * *					
-12	530019	Seal Assembly, Oil	1	1	1	1	1
-13	530956	. Spring	1	1	1	1	1
-14	35956	Plate, Moisture Impervious	1	1	1		
-15	3991	Flange, Propeller Hub	1	1	1		
-16	401507	Washer	6	6	6		
-17	24768	Bolt	6	6	6		

NOTES: ① See Section VI for complete bearing kits.

③ Used on -12, -14, -16 & O-200 Models.

④ For Models with the letter "F" stamped after the Model number (Example: C75-8"F").

C75
C85
C90
O-200

CONTINENTAL[®] AIRCRAFT ENGINE

OVERHAUL MANUAL



FAA APPROVED

Publication X30010

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AUG 2011

SECTION III

GENERAL DESCRIPTION

3-1. DIFFERENCE BETWEEN MODEL GROUPS.

Models within the C series are grouped according to rated power, the groups being 75, 85 and 90. These three model numbers are prefixed by the series designation "C". Models in the C75 group differ from the corresponding dash numbered models in the C85 group only in calibration of the carburetor installed. C90 models differ from C75 and C85 models in the design of several major parts and accessories, including the crankshaft, camshaft, crankshaft gear (in -8 models only), carburetor, oil sump, connecting rods, pistons and valve springs. The O-200, in turn, differs from C Series in the design of its crankcase, camshaft, crankcase cover, carburetor and oil sump. It differs further in that shielded ignition is standard equipment. As indicated in Table III, C90 and O-200 models have a longer piston stroke, resulting in a higher compression ratio and larger piston displacement. A higher fuel octane rating is required by these features.

3-2. SIGNIFICANCE OF C SERIES DASH NUMBERS AND LETTERS

Following the series letter and power designation, and separated from them by a dash, a figure and, in some instances, a suffix letter or two in the complete model number denote the installation of certain parts or equipment designed to adapt the basic engine to various classes of aircraft. Those dash numbers and suffix letters which have been used to identify production models built to date are as follows:

- 8: No provisions for starter or generator.
- 12: Starter, generator and associated parts installed.
- 14: Lord Engine Mount Bushings installed. Otherwise like -12 models.
- 16: Vacuum Pump Adapter. Otherwise like -12 models.

F: Flange type crankshaft installed (replaces tapered shaft).

H: Crankcase and crankshaft adapted to feed oil to hydraulic controllable pitch propeller.

Various combinations of the foregoing dash numbers and suffix letters are used to describe equipment of the different models. In the following discussions and instructions the term "-12 models" will indicate all models equipped with starter and generator, whether or not they have flange crankshafts (12F). The absence of a suffix letter in the model number, as C75-12, indicates that a tapered crankshaft is installed. The Lord mount bushing equipment of C90-14 and O-200 models is illustrated in Figure 16.

3-3. MODEL CONVERSIONS.

Conversion of C75 and C85 models to corresponding dash numbered C90 models is not approved, due to the nature and extent of parts differences and to the possibility of unsatisfactory results. It is not possible to convert any -8 model to a -12 model, because the -8 crankcase is not adaptable to the -12 crankcase cover in several respects. Conversion of -12 models to -8 models is not approved for similar reasons. Neither -8 nor -12 models can be converted to -14 models in the field because of the special machining required for Lord mount bushings. Conversion of C75 models to corresponding dash numbered C85 models may be accomplished in accordance with instructions contained in our Service Bulletin on this subject. Installation of a flange crankshaft in place of tapered shaft is considered merely a crankshaft replacement and does not require factory approval or special instructions, however, engine identification plates bearing model or dash numbers, other than those originally assigned, cannot be issued unless an application for conversion approval has been submitted and approved by the factory Service Department.

A notch is provided to accept the tang of these bearings. Below each cylinder pad, and on the horizontal plane of the camshaft, two lateral bosses inside the case are bored to form valve lifter guides. These bores emerge at the case side surface, and a pushrod housing adapter, installed over their open ends, is retained by three case studs and nuts. Between the line of lifter guides and the line of cylinder openings at each side of the case are the main oil galleries extending from front to rear. The oil galleries are plugged at the front. Current C series crankcases use a 5/8-18 hex head plug and annular gasket. Earlier C series and current O-200 crankcases use (2) 3/8 NPT countersunk hex pipe plugs. An enlargement of each casting's lower parting flange at the front end forms half of a boss which is machined and studded to make a mount pad for a vacuum pump on the -16 and O-200. A semicircular flange at the rear of the crankcase bottom surface is machined flat and studded to form the front half of the oil sump mount pad. Two studs driven into bosses at the lower parting flanges are used for attachment of the intake manifold. The crankcase breather elbow is screwed into a tapped boss ahead of No. 3 cylinder. An upper and a lower arm at the rear of each case casting affords an engine mounting point. For -8, -12 and -16 models the end bosses of mounting arms have front and rear conical recesses for rubber mount bushings. The arm bosses of -14 and O-200 model crankcases are bored through and counterbored for Lord mount bushing assemblies. Parts of the Lord mount assembly are illustrated in Figure 16. The flange surrounding the rear end of the crankcase is machined flat and studded for attachment of the crankcase cover. Locations and lengths of the studs are different in -8 and -12 crankcases. The crankcase of -12, -14, -16 and O-200 models has a hole bored through the rear web above the rear main bearing to hold the starter pinion pivot. A dowel driven into the left side of the hole fits into the pivot to hold it in position. Some models have a studded mount pad for a fuel pump on the 1-3 side of crankcase.

3-7. CRANKSHAFTS

Each type of crankshaft is machined from a single forging. The four crankpins are spaced 180° apart. Starting at the rear and proceeding forward, the crankpin numbers are 1, 2, 3 and 4, according to the cylinders which they serve. Each crankshaft has three main journals, the front one being immediately ahead of No. 4 front crankcheek. The cheek is ground flat around the journal and contacts the rear crankcase thrust washer to

transfer propeller thrust. A small anti-thrust flange at the front end of the front journal acts as an oil slinger.

CAUTION

This design should not be used in pusher installations.

Older types of shaft had a taper on the front side of the slinger flange. These cannot be installed in present type crankcases because of interference between the taper and the case oil baffle. The slinger flange of present type crankshafts has parallel sides. All crankshafts are center bored for lightness. The front bore runs out at the front crankcheek and the rear end bore at the rear crankcheek. Steel oil tubes are permanently installed in holes drilled from the front and rear journals through crankcheeks to Nos. 1 and 4 crankpins. Oil holes are drilled through solid cheeks from the center journal to Nos. 2 and 3 crankpins. The tapered type shaft has a slot along the propeller hub taper for a square key to drive the steel hub used with it. The hub fits tightly on the taper and is retained by a tube nut, which is locked by a flat head pin. A snap ring in a hub groove ahead of the nut flange acts as a hub puller. The propeller is clamped between the steel hub flange and a loose steel flange in front by six bolts and nuts. The flange type shaft has a propeller mount flange forged on its front end with six tapped bushings pressed into holes spaced equally around the flange. Six bolts, screwed into the shaft flange bushings, clamp the propeller between a loose front flange and the shaft flange. The loose front flange and the six bolts are not supplied as part of the O-200 engine. A steel cased oil seal is installed over the front end of tapered shafts and is retained in the crankcase recess around the shaft opening. With flange type crankshafts a split, composition seal is used. It is made in one piece, and the seal lip is held against the shaft race by a spring.

3-8. NITRIDED CRANKSHAFTS

Latest types of flanged and tapered crankshafts have nitrided main journals and crankpins. Flange shafts for C90 and O-200 models have always been nitrided. These are identified by a 1/4 inch hole drilled through the propeller mount flange. Nitrided flange type shafts for C75 and C85

models are identified by the letter "N" stamped on the edge of the propeller flange. Tapered shafts for C75 and C85 models, if not nitrided, have four hub nut lock pin holes at the front end. One additional hole is drilled to identify nitrided shafts.

3-9. CRANKSHAFT GEARS

[REDACTED] screw holes are unequally spaced to assure correct installation. The space between two adjacent punch marked gear teeth points to the camshaft when No. 1 crankpin is at T. D. C. [REDACTED]. In -12, -16 and O-200 models a cluster gear is installed. Its large wheel has beveled teeth and is driven by the starter pinion.

3-10. CONNECTING RODS

Connecting rod assemblies of C90 and O-200 models differ in dimensions from those of C75 and C85 models, but the two types are of similar design. The rod and bearing cap assembly are made from a single steel alloy forging, which is sawed through the center of the big end before the bearing seat is bored. Each half of the split big end bore is notched to accept the tang of the semicircular bearing insert which fits in it. The replaceable crankpin bearing inserts are thin steel-back shell type, lined with special alloy metal. The bearing cap is attached to the rod by two special bolts and hex nuts. The cylinder number is stamped on the upper bolt boss of both rod and cap. A tapered "I" beam connects the big end and the piston pin boss. The piston pin bushing is a plain bronze sleeve, pressed into the rod boss and bored parallel to the big end bearing. The original type solid piston pin bushing has been replaced by a single piece, split type bushing in both C75, C85, C90 and O-200 type rods.

3-11. CAMSHAFTS

All camshafts installed in C75 and C85 models are flame hardened iron castings. The same material was employed in early production C90 camshafts. Present type C90 and the original O-200 camshafts are alloy steel forgings. These are identified, when new, by an over-all black Parko-Lubrite coating and an underlying copper plate on unfinished surfaces. All C90 and O-200 camshafts are reduced in diameter between cam lobes to provide connecting rod clearance. Standard camshafts for C

series carburetor engines have an eccentric machined at the front fuel pump lever. A special camshaft with two eccentrics is available for installations which require a second fuel pump. Camshafts installed with vacuum pump equipment in -16 and O-200 engines have no pump drive eccentric. The front end of this type has six tapped holes for screws which attach the vacuum pump drive bevel gear. A special combination gear and eccentric is also available for the vacuum pump and side mounted fuel pump. The C90-16 and O-200 also have a camshaft for a side mounted fuel pump with no provision for a vacuum drive gear. The gear is spaced from the shaft end, for correct backlash with the vacuum pump gear, by one or more shims, which are available in two thicknesses. A few of the early production O-200 engines have these shims installed. Current production engines do not require these shims to provide proper backlash. All camshafts have three journals. The center journal is plain, while the front journal has a deep groove to register with oil holes drilled from its bearing into the main oil galleries. The rear journal has flanges at its front and rear ends to restrict camshaft end movement in the rear bearing. The rear flange has four unequally spaced tapped holes for the camshaft drive gear retaining screws. Three cam lobes between each two journals operate valve lifters for two cylinders. In each group, the outer lobes each operate one exhaust valve lifter, and the center lobe operates two opposite intake valve lifters. Lobes of O-200 camshafts have a greater lift than others.

3-12. CAMSHAFT GEARS

Camshaft drive gears installed in -8 models are single spur gears with the web at the rear, while those in -12, -14, -16 and O-200 models have both external and internal teeth, and the web is at the front. The internal teeth drive the generator gear. Both types of gears have a square hole in the center to receive the oil pump driving impeller shaft. A ground recess in the front side of each gear web fits closely over the camshaft pilot flange. The gear is retained by four hex head screws in holes spaced unequally around the web. Thus, the gear can be installed in only one position in relation to the cam lobes. A punch marked tooth is meshed, at assembly, between two similarly marked teeth on the crankshaft gear, and this simple operation assures correct valve timing without measurement.

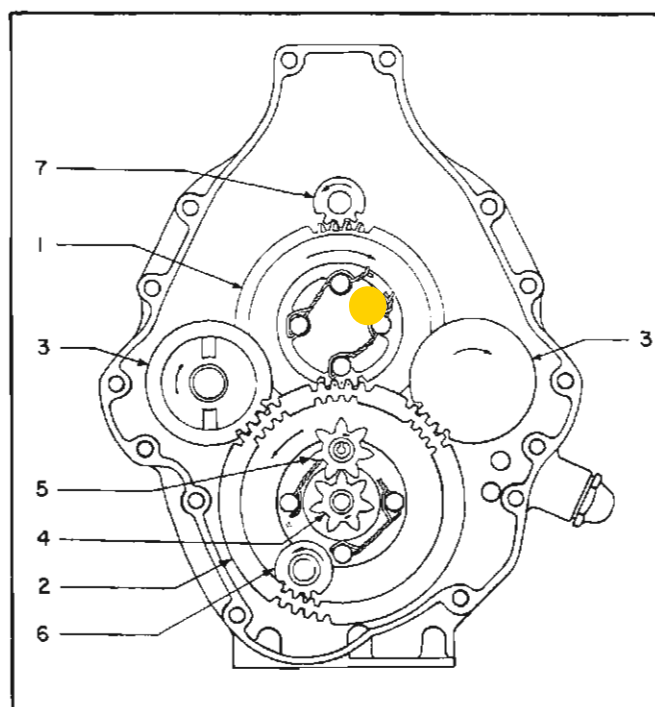
generator drive gear (6), of -12, -14, -16 and O-200 are driven by the camshaft gear. The tachometer shaft, in the -8 model, is driven by the oil pump drive impeller shaft, while in the -12, -14, -16 and O-200 models it is driven by the pump driven impeller shaft. Starting power is transmitted to the crankshaft by the starting motor pinion (7) engaging the large gear section of the crankshaft gear on -12, -14, -16 and O-200 models.

3-28. CARBURETOR INDUCTION SYSTEM

The intake manifold is attached to two long studs in the crankcase lower flange. The carburetor is attached to a studded square flange on the bottom of the manifold. The air passage through the manifold divides into four horizontal outlets, to which the cylinder intake tubes are sealed by rubber hose connectors and clamps. The intake tubes are connected by the same means to cast aluminum elbows, attached to the studded cylinder intake port flanges. The air intake housing is attached to the studded carburetor bottom flange. The flat sheet metal housing flares upward at its front end to match the square air filter. The filter is fastened to the housing front flange by four slotted head studs, which may be released by a quarter turn. A sheet metal bracket ties the front end of the intake housing to the manifold. A lever-operated plate valve in the intake housing opens and closes a hot air inlet to the manifold. A collar at the right rear corner of the housing attaches the hot air supply tube. A fuel drain tube is welded to the bottom of the intake housing.

3-29. OIL SUMPS

The sump body is a welded assembly composed of front and rear halves of pressed sheet steel. A thick mounting flange ring, four brackets, an oil fill neck and a drain plug boss are welded to the body to complete the assembly. The location and length of the oil fill neck vary to suit the aircraft installation. A bracket is welded to the neck for support by attachment to a stud in the lower crankcase mounting arm. The tubular steel neck has a bayonet locking device at the outer end for quick attachment of the gauge cap. The sump drain boss is tapped for a 5/8-18 plug, which is sealed by a copper-asbestos gasket. The mount flange ring is drilled for the six attaching studs in the crankcase and cover pad. The oil gauge rod is graduated in quarts to the "FULL" mark. At present, sumps are attached with elastic stop nuts to undrilled case studs.



1. Crankshaft gear
2. Camshaft gear
3. Magneto drive gears
4. Oil pump driving impeller
5. Oil pump driven impeller
6. Generator drive gear
7. Starter pinion

Figure 10. Gear Train of -12, -14, -16 and O-200 Models

3-30. IGNITION SYSTEM

3-31. UNSHIELDED

Unshielded ignition cables and unshielded spark plugs are standard equipment of all C75, C85 and C90 models. Individual cables connect all upper plugs to the high tension terminals of the right magneto, and all lower plugs are connected to terminals of the left magneto. Unshielded ignition cables are of conventional construction, with high tension insulation over 19 strand copper conductors. Each cable assembly is attached to a spark plug by a safety lock terminal and has a magneto end terminal of the type required by the magneto installed. Four plate brackets, attached to crankcase studs, support each pair of upper cables and each pair of lower cables near the cylinder bases. Two similar brackets, attached by magneto retaining nuts of -8 models and by crankcase cover retaining nuts of -12 models, support four ignition

16-6. GEARS AND CRANKCASE COVER

Rotate the engine bed so that the front end of the crankshaft is downward, and lock it in position. Install parts at the rear of the crankcase in the following order:

Rotate the engine bed so that the front end of the crankshaft is downward, and lock it in position. Install parts at the rear of the crankcase in the following order:

- a. 
- b. Turn the crankshaft until No. 1 crankpin is at T. D. C. The gear tooth timing marks will be toward the camshaft.
- c. Turn the camshaft counterclockwise until No. 1 exhaust lobe (rear) approaches its closing position and No. 1 intake lobe is beginning its lift. Install the camshaft gear on the camshaft pilot with its punch marked tooth meshed between the marked teeth of the crankshaft gear. Install four hex head retaining screws.

CAUTION

Use screws of correct length on each gear. Refer to Parts Catalog for lengths required by each model.

- d. Tighten the eight gear retaining screws to torques specified in Section XVIII.
- e. Install lockwire through the drilled heads of the retaining screws of both gears to connect them in pairs. The wire must pass around the sides of all screw heads, not over their ends, and it must be twisted in the direction necessary to prevent the end loops from rising and led from one screw to the next in the direction necessary to prevent either screw from loosening. Draw the twisted lockwire tight, and bend the twisted ends down.
- f. Work into both surfaces of the proper cover gasket a small quantity of a non-hardening gasket paste, and place the treated gasket over the studs and on the crankcase rear surface.

The dowel holes in the gasket must fit over the crankcase dowels.

NOTE

The cover gasket for -12, -14, -16 and O-200 model crankcase does not have or need a hole for the left oil gallery.

- g. Lower the crankcase cover subassembly over the studs, and seat it on the cover gasket, as shown in Figure 36, for -12, -14, -16 or O-200 models, turning the crankshaft slowly to align the oil pump drive.
- h. If the engine is a -12, -14, -16 or O-200 model place plain washers, lockwashers and plain hex nuts on all crankcase cover retaining studs, except the one through the generator mount pad. Tighten to specified torque these seven nuts and the third retaining nut of the oil screen housing. Loop a length of lockwire around the nearest cover retaining studs to the oil screen housing and oil pressure relief valve cap, and twist the wire. Twist the two lockwires and lead them to the oil pressure relief valve cap and the oil screen cap, respectively, in a counterclockwise direction to engage the cap corner holes. Install a drilled hex head plug and new copper-asbestos gasket in the oil screen cap hole. Tighten the plug, and secure it with the ends of the lockwire in the screen cap. If the engine is a -8 model install all of the ten retaining washers, nuts and safety the oil screen and pressure relief valve cap in the same manner as described.
- i. With a sharp knife, cut out the strip of the crankcase cover gasket which crosses the oil sump pad opening, then trim the lower ends of the gasket flush with the sump mounting pad.

16-7. VALVE LIFTER UNITS AND PUSHROD HOUSING FLANGES

Rotate the engine bed so that the front end of the crankshaft is upward. Then:

- a. Install hydraulic units in the valve lifter bodies with their plungers outward. Before installing each unit, make sure that its spring