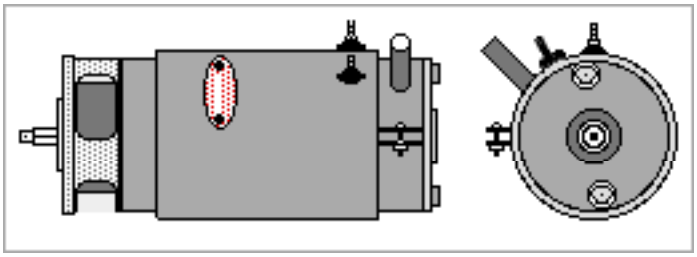
GENERATORS

For the 120/140/140A's

Generators for the Continental C-85, C-90, and O-200 Engines:

This is a collection of generator capacity data followed by a section which suggests that owners should consider adding a generator blast tube to their planes if they have these generators.



Generators:

Generators first installed on the Cessna 120/140 planes had a capacity of 12 amperes, growing to the sizes noted below, including some that had the 25 amp type installed.

Application	Delco Interchangeable P/N	Volts	Amps	Delco Regulator P/N
Cont. C-85 to C-145	1101876	12V	12A	1116383
Cont. E-185	1101879	12V	25A	1116384
Cont. E-185	1101887/1101880	12V	35A	1118704
Cont. E-185	1101908/1101888	12V	50A	1118713
Cont. C-85 to C-145	1101890	12V	20A	1118736
Cont. C-75 to C-145	1101898	12V	35A	1118704

The other sizes/part numbers are mostly for other engines such as the O-300 for the 170/172, but all of these have been seen on the little planes.

1101879	25A	1118384	(or 879)
1101887	35A	1118704	
1101913	35A	1118704	

One of the best sources of which generator goes with which regulator is El Reno (Trade-A-Plane); this listing came from my oldest Aircraft-Spruce catalog. Today, Aircraft-Spruce lists mostly alternators.

Current Ratings and Actual Usage:

Conservative electrical system rating is that the load should not exceed a continuous maximum of 80% of the generator capacity. When one takes a look at the electrical usage of the plane versus the output available from the 12 amp or 20 amp generators, it is soon apparent that you want to be very conservative with respect to using extra electrical loads. For our planes, the expected usage was an amp for the three instrument panel lights, and two or three to each of the external lamps and then the radios were added; "everyone" knew the landing light would only be used for a very short time while landing because of its high current requirements & drag if the swing down type (nearly 20 amps).

Leaving a leading edge landing light on all the time would carry a constant penalty of 9 or 18 amps (the swing-down Grimes type uses 250 watts or 20 amps and nobody flies with them on all the time). The 140A has two of the 4509 type, and their draw together is about 18 amps and you cannot use just one, nor

will you have notice they are on in the daytime except for the switch position. The radios with tubes seldom were satisfied with less than 4 amps when receiving and then there were the position lights and the dash lights so a night flight could be quite marginal or a race to battery depletion. Even those with the 35 amp size generators should consider the loads they apply and when they apply them; if you are on final, with the landing light, a beacon or two, the position lights, instrument panel lights and the radios on, then keep your engine speed up because generator output is directly tied to the engine speed. The leading edge lights on 120/140's are mostly individually controlled, so 9 amps each.

I noted several queries on the sites as to what the ampacity of the wire was on the planes when originally made. Rather than guessing, I looked and compared the wire from the generator output to the bus. It is size 12. From the AC-43 listing at the end of the article, you can note that size 12 is blessed for use at up to 41 amps so the generator output wire could handle all generators through the 35 amp size.

Missing Blast Tubes for the Generators:

Our generators, regardless of size, should have had a blast tube delivering cooling air to them all these years, according to the people who made them, Delco, and as passed along by Continental. Although it appears sacrilegious to many of our co-owners when I say it, I suggest that Cessna forgot to call out the expected and necessary blast tube for delivery of clean, cool air to the generator. If I don't say "forgot", then one might conclude they deliberately left off a specific requirement of Continental's and Delco's and that seems unlikely.

The Delco manual notes that the family of generators for aircraft has two unique features; one is that they have a stub blast tube installed for cooling air instead of the integral fans which were a normal part of the look-alike generators used on cars and tractors, and the other is that they have "lifetime" lubricated bearings, whereas those for cars were made with the flip top oil reservoirs and fillers. These made-for-aircraft-only generators are called out for the Continentals we use. Close observation will show that the missing blast tube, fed with high pressure air from in front of the engine baffling to the little stub inlet tube on the generator, is intended to shower the commutator with clean, cool air which then passes forward over the generator rotor and field windings to exit from the generator case near the front of the generator, thereby also keeping the inside of the generator from being exposed to the "dirty, oily" air inside the cowling behind the engine and the baffling.

Delco specifies the static pressure necessary for adequate cooling and in the Continental overhaul manual, the requirement for cooling air is also mentioned several times; the recommended pressure to the generator via the blast tube is to be 1-1/2 inches of water (0.087 lbs/sq in). Cessna, in their plane parts manual, shows the generator blast tube stub in several views, but neglects to call out a tube/clamp combination to serve it. Delco established the requirement for cooling air based on their expectation that it was a bit silly to have an internal fan when there was all that cool, clean, higher pressure air to be had through a tube from the engine cooling plenum formed by the baffles; it seems reasonable that the fanless feature pleased the plane makers. Continental believed what Delco said and calls out for a certain amount of air pressure to be fed to the generator in their engine installation manual, and then Cessna dropped the ball.

The realization that something might be missing was induced when others saw my plane with the blast tube to the 35 amp generator—I thought that was "normal" and they thought it odd and wondered why. The left side of the rear cylinder baffle has a hole which nearly matches the one on the right which takes cooling air to the oil sensor area, and a 7/8 inch ID SCAT tube delivers the air to the generator's stub inlet tube.

One of the human oddities we have learned we have to be wary of is the built-in absolute faith of owners toward the designers. There are those owners who are adamant that, if the little stub inlet tube that comes with the aircraft generators is only oriented such that it looks like the picture of the generator in the Cessna manual, all will be well, because "Cessna must have known that the airflow in that area would provide.....". Nonsense. There is certainly no clean, fresh, cool air in that area and it certainly does not have a pressure differential of the specified value from the rear of the generator to the front.

It is guaranteed that nobody, then or now, knows what the air currents and patterns are behind the engine; the air behind the engine is mixed up and untrustworthy, certainly incapable of developing the pressure called for in the manuals. If you chase back to the Continental manuals, you will see that Cessna simply

copied the views in the Continental manuals, including the angle of the generator cooling inlet stub. Because those views are identical in the Continental and Cessna manuals, it seems apparent that Continental positioned the inlet stub where they did in the pictures of the engine in order to achieve visual contrast so it could be seen (said another way...if they had tilted it up to make sense for the cool air delivery, the black tube on a black background would have made it invisible) but they never intended to suggest that orienting the inlet tube as shown would magically give the cooling needed. It makes no sense to propose that Continental, while stating several times that a positive pressure air flow, available only if one taps off the ram pressure from in front of the baffle, would turn around and show that a sourceless angel of air would do the job!!!!

The hazard of not having it? The generator will run hot, it's lifetime will be reduced, the brushes will be denied consistent good contact with the armature because of the oil film...on and on. Recall the droplets of oil on the inside of the cowl after a flight, so spread out that it seems as if a little boy was inside with a slingshot flinging oil? Consider the likelihood that some of the oil or oily air will get into the generator, and then imagine how much good that does when deposited inside the generator, especially on the commutator but soaking into the material of the rotor and field windings as well. We know how little oil it takes to smear the whole belly. A tiny, tiny amount of oil on the commutator would go a long way to impede proper output.

It took Cessna a long time to learn what was needed, but they finally added the blast tube on later planes with generators and then repeated the error of leaving off the cooling tube when they went to alternators and later yet reversed that shortcoming by adding a huge blast tube for the alternators.

Note. If you decide to add the blast tube, you will want to rotate the stub blast tube that comes with the generators such that it points up instead of leaving it pointing down; loosen the generator's brush band and look through the stub tube to verify that your new position does not make the opening of the stub tube coincide with the case struts and thereby block the air you are trying to get inside.

Nobody will say thanks for making the change, so it will be up to you to appreciate you have extended the life of the unit and will probably receive a more reliable output as well.

Coupler and the Service Bulletin:

GENERATOR ATTACHING PARTS FOR CONT. C85, C90 & O-200

REF.	P/N	ITEM	PRICE
#2	352068	Oil Seal	$4.40
#3	530406	Hub Coupling	$131.50
#4	352030	Retainer	$12.40
#5	626543	Bushings (2)	$3.40
#6	530407	Sleeve	$52.25
#7	531325	Gear	$215.00
#8	530412	Slotted Nut	$14.50
#9	35019	Gen. Gasket	$3.90
#10	352179	Starter Gskt	$3.35

From a new catalog from Aircraft-Spruce, this table of parts for the generator is copied. Every few years, you are supposed to replace the two item five rubber shock absorbers and their container, item 4, is often too worn to keep and so should also be replaced. The prices are higher now of course and order two of the item 5. (Yes, Spruce has been told over and over that the starter gasket is in the wrong place. They like it there to confuse customers.) Note the cost of the special nut; there is a reason, it is special, and you won't be able to use anything else because of clearances. Don't lose it!

The oft-neglected drive coupling assembly showing the two rubber pieces and the "can" they go in and the wear pattern on one removed. The wear pattern will eventually pierce the can if let go long enough. Although the items are supposed to be checked every 500 hours, the step requires that the generator/alternator be removed for the inspection and it is often skipped and many are unaware of the service letter.

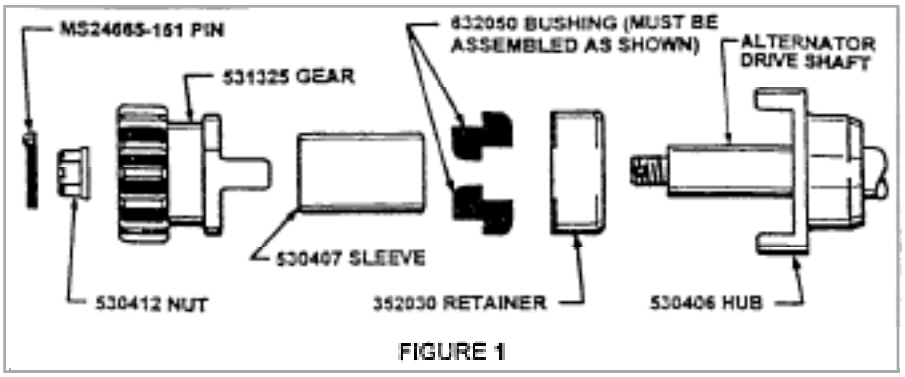
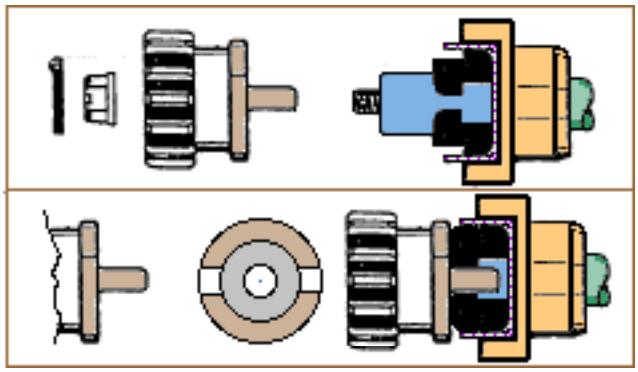


FIGURE 1

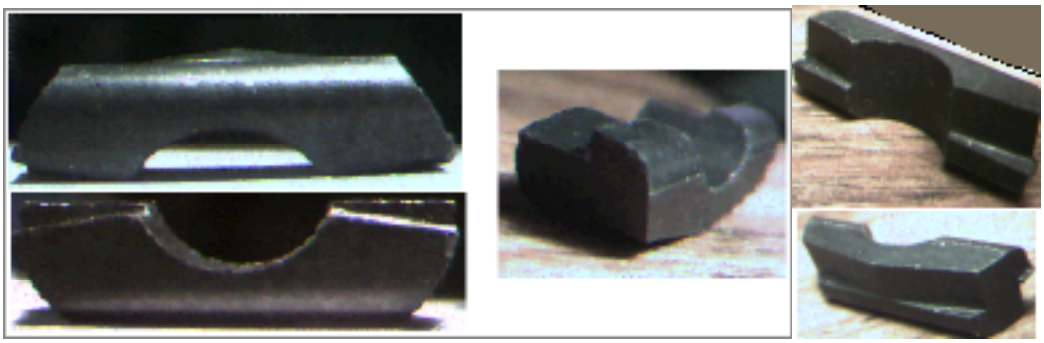
The source of the coupler information can be found in the February 1998 issue of the Light Plane Maintenance; they also note that the Teledyne Continental service bulletin is TCM SB#95-3A. It is believed that few mechanics are aware of the service note and its applicability to the C engines and the O-200. The "rubber" shock absorbers have a single unique shape and nothing other than this sketch has been found to indicate the correct orientation of them in the "can". The figure renditions in the catalogs are so small and so poor that the shape details are not apparent. The figure from the Light Plane Maintenance article has lots of errors....the hole in the "can" is too small for the sleeve, the sleeve is shown sectioned but its internal diameter should be the same as the drive shaft and the drive shaft is depicted as being hollow, but is not. Here is a figure I created showing how the parts are supposed to nest. The top rendition copies the LPM figure in that it shows the cushions as their ends would appear; the bottom shows the cushions as if sectioned in the middle and are a truer display.



This view is correct because Jim Williams did some research and confirmed that the image from Light Plane Maintenance is the right way. Later, I show lots of views of the cushions so you can see the right orientation. At the end of the article, I have included the generator-pertinent parts of Jim's email; if that does not convince you that taking off the generator/alternator for a look at the next annual is worthwhile, I don't know what will. Order the cushions! Remember, the A&E is obliged only to "confirm that the accessories look all right from the outside". And log the special event and the new cushions.

This photo of the couplers and the can show the incorrect orientation of the cushions on the left and the correct installation of one on the right.

Details of the cushions look like this. The original parts were without all these special features. These are not shown anywhere else so this greater than usual display of pictures to indicate the details.



Subsequent History:

Every maker of generators and alternators would tell you the same thing—keep them as cool as possible for long life. Finally, before ceasing manufacture of the 150/152's, Cessna had the big alternators with an internal fan, with a large! blast tube feeding high pressure air to a shroud at the end bell of the alternator.

The 150's started out with the 20 amp generator, just as the 140A's had used, but the next year, in 1960 (the 150 history says '63), some models came with the 35 amp size and then it was an option on following models. It is not apparent how long the 20 amp was available as an option, nor does Cessna state if they went to the 35 amp unit as standard during those years. In '67, they started using the 60 amp alternator, and in 1972 they added the rather unique, totally misunderstood overvoltage device and overvoltage protection (OVP) alert light to the alternator subsystem. It took a while, but they finally did it right and then they did even better...they took it off.

Suggestions

If you have suggestions for improvement, by all means send the information to me for inclusion in the next version.

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From Jim Williams via email:

Methinks you might have an article on generators in the mill. I have had my share of heartaches here as well, but fortunately not the disaster it has the potential to be. When I bought my plane it was one of the cleanest inside and out I could have hoped for. Great paint, fabric, and interior, no corrosion, etc.

Got a rebuilt starter and everything was OK for a while, then the generator quit. I removed it and what I found sent cold chills through me. You are familiar with the special castle nut with the built-in washer (or shoulder) that

retains the drive gear to the gen. shaft. Well, it seems that someone before me didn't think it was all that important, so they just used a regular castle nut (without even a regular washer). I grabbed the gear and just slipped it right off the shaft, right over the castle nut! Nothing but the Good Lord held that gear in place.

Then I got to thinking (panic) and looked inside the engine at the camshaft gear with which the generator gear meshes. I found that the generator gear HAD shifted forward enough to neatly clip the safety wires on the cam gear bolt heads and break them, but fortunately the bolts were still in place and no other damage was done. The cold chills got colder. Boy, it was a pain replacing those safety wires through the generator hole, and yes I had to pull the engine to do it.

The rubber couplings for the generator were almost non-existent and the metal cup was cracked. To this day I can't believe that this wasn't a catastrophic failure. I cracked open the generator and couldn't make sense of what was going on in there. I finally had to find a similar one and take it apart to find out what all was missing: the front bearing-retainer ring and associated fillister screws along with the appropriate spacers to stop end play and place the shaft with the proper amount extending out of the front cover to accept the drive mechanism. A friend loaned me a 20 A gen. which I installed and am still flying (still have the 12 A regulator, though). I "rebuilt" my gen. with new bearings and front seal, a bearing-retainer ring stolen from a junker, new couplings and metal cup, and the all-important special castle nut (18.00 for a nut!).

I had to take my best guess at how to properly take up the space on the shaft forward of the armature and aft of the commutator. It's easy to just take up the endplay, but you have to divide it up properly with spacers at the front AND rear to get the right amount of shaft extending out of the front case. I'm still not sure that it's right. Go and try to find that information! The shops are no help, of course.

Their answer is "we don't sell parts, just units". We did a growler test on the armature, checked the field for continuity and found no problems. All this, and I still don't know why it ever quit generating!

If I could have gotten my hands on the "hacker" who last worked on that generator I may have been writing this from jail. I bet he was the same &@#!$*! that "worked" on the starter. I am keenly aware of how blessed I was that no appreciable metal went through the engine. One other thing. I had trouble discerning which side of the rubber coupling goes into the cup - the two sides are different, but I couldn't follow the design. I'll bet you're gonna cover that. **Jim Williams**

Many owners change to alternators; when that is done, the output wire size must change to accommodate the ampacity of the alternator. The output wire on the planes was/is size 12, so it could handle all generators up and through the 35 amp size. Size 8 should be installed for a “60” amp alternator. See the alternator article for comparison and features.

Wire gauge	Nominal Conductor area in Circular Mils
24	475
22	755
20	1,216
18	1,900
16	2,426
14	3,831
12	5,874
10	9,354
8	16,983
6	26,818
4	42,615

AC 43 13 lists these ampacities for wire

Gauge of wire	Routed singly, not in a bundle	Routed in a bundle
8	73	46
10	55	33
12	41	23