Alternator Considerations

Changing from a generator to an alternator on the C-85/90 or O-200 Engines

Considerations:

The greatest advantage of the alternator is its ability to provide a significant output (about 14 amps) while the engine is at idle, and that means you will not deplete the battery on the ground, as is the typical case with a generator. It is incredible how rapidly the idling alternator refills the discharge of the start effort. In these days of wanting as many alerting visual aids as possible, many fly with the leading edge landing/taxi lights on all the time the engine is running and that would be a significant load with a generator but reasonable with the alternator. With the generator, it was always frustrating when in the landing pattern at night to have the lights dim just when you needed them most and that problem goes away with the alternator. Is it worth it? I have yet to hear of an owner who took off an alternator to put a generator back on! The cost varies; if you can find a system from a newer Cessna, you will avoid the new parts cost of $600 to $1000, less installation. One shortcoming; unlike a generator, the alternator must be fed current to start the process of producing an output. That means, with a dead battery, you are non-electrical regardless of what you do until you get the battery recharged.

Philosophy:

If you would like to know what makes an alternator work and which of the major types you need to use, the Zeftronics site has much the best information, going from the explanation to showing the innards of the regulator and the various hookups and that is followed by troubleshooting methods and sequences. Cessna "evolved" the design as the planes progressed, starting without OVP's (OverVoltageProtection) as part of the circuit and then adopting them and adding shielding on all the wires. On the site www.AMTONLINE.com is another outline of what to look for and how to troubleshoot typical alternator system woes, including the wiggling ammeter fault. Downloading the guidelines from both sites so that you know what to avoid at installation, what to expect, and how to correct problems if any crop up is recommended.

Most use the same alternator and regulator and circuit as the 150/17x planes, thus making approval a lot easier. The alternative STC-ed types and brands are presented in Aircraft Spruce. Some come as packages of alternator, regulator (with OVP), filter, and circuit breaker. The rebuilt "Ford" design alternator used on the 150 costs about $450 because you have no same-type core ($150 for the core lack). Just below the Ford alternator presentation, they get a bit tongue tied in explaining that the electromechanical regulator made by Ford is no longer available (that is good, because the transistorized type offers better life and steadier output) and then suggest one by Electrosystems and offer the Zeftronics on a different page. One of the International club members offers an STC...Fred Lagno...and his ad is in the Newsletter.

Take a look; Zeftronics.com, Electrosystems.com, and the www.AMTonline.com sites.

337 or STC and 337:

The easy way or the harder way. The 337 alone, if acceptable to all concerned, allows more latitude in what components can be used. Discuss which path is to be followed with the A&I first and get some 337 samples to learn what is involved. STC's allow no latitude as to which equipment can be added (such as alert or warning lights) and the last step of them is turning in the 337. But make sure that the selected route is okay with your A&I and FSDO before you START!!

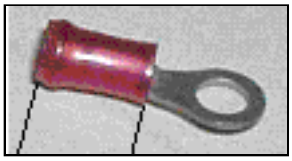
New coupler:

Make sure the new installation includes a new two-piece rubber coupler set for the drive shaft of the gen/alt. Available from Spruce (see later chart), suggested to ensure good coupling, and because it is the subject of a service letter. Because the cup which holds the rubber pieces is often worn badly, get a new one of those, too, also from Spruce. There is a service letter from Cessna about the "new cure" coupler. SB 95-3A. If you would like more information about this feature, see the Generator article. Order the parts before you start the exchange.

The Gears:
They did this one right. The coupler and the gear used on the generator is the same which can be used for the alternator. Make sure you protect the gear and the special nut! In a letter to John Hall to respond to his query as to whether the gear and assembly could take the higher torque requirements, the answer from Continental to him states that the answer is yes, that the gearing and coupling could take the torque for the C engines and the O-200. Thanks to John Hall! Never send the gear with the core.

Tools:
Have a good magnet handy because it is very likely you will drop one or more of the nuts or washers into the unit. Happens to everybody. Awkward things to install. Easy with the mag and tach drive housing off! Not quite so easy with just the tach drive off and more difficult with the tach drive housing still on.

Crimpers today are readily available for $20 at good auto supply stores, as are wire strippers. The "good ones" are so much better in the results than the cheaper, poorer crimpers and strippers meant only for hooking up trailer lights that scrimping here is foolish. The good strippers mean you don't get scraped or nicked wires and so no failures from bending fatigue, and the crimpers mean you get connections good for another 50 years.



Soldering is not an acceptable option for terminals in planes. No airplane manufacturer uses that method. Solder is not a solid but is classified as a "supercooled liquid" which means it yields over time to pressure and stress; moreover, it is resistive. Crimps are the best connection. Only the best design of terminals, such as from AMP should be used, because they include metallic support for the insulation. The metal crimp barrel of the figure goes all the way between the two black lines.

Ampacity:
Ampacity; 60 and 50 amp alternators are the most common, but the one used on so many 150's is the "60" amp type based on the Ford design. The ampacity of the Ford-built alternator is often given as "65 amps", but it is really a 60 amp unit. The Jasco kit, if your A&X will let you use it, is 40 amps.

There are quite a few significant differences in the plane versus car alternator so don't take a shortcut; the article with the details appeared in *Light Plane Maintenance.* I have found that warnings do little good so here are some of the details. The Ford alternator off a car is NOT the same as the one for the airplanes, with these features, at least, different. The Ford for the plane engines is made to turn the opposite direction (which affects cooling), the bearings are lifetime lubricated, the fan turns the opposite direction, the hold-together bolts are different and the brushes are different (composition changed for altitude effects). Yes, I know that FBO's in Oklahoma put auto alternators on their training planes.

Regulators and OVP's (Over Voltage Protection):
One of the mysteries of Cessnas is why they needed to add the OVP circuit when all the millions of cars on the road for decades have never needed it. However, some STC and 337 write-ups require them. The original OVP's used by Cessna came in a little unsupported package which included a filter capacitor (which dried out over time and induced false alarms and shutdowns galore), a relay, the overvoltage sensor, and an indicator light for the panel which most Cessna owners have never seen lighted.

Thousands and thousands of the OVP circuits were based such that the sensor, when it sensed an overvoltage, tripped a relay or an SCR so that the field current was interrupted, causing the alternator to stop its output. To reset on a Cessna with the split master switch, the pilot had to carefully manipulate the "correct" half of the Master switch to Off and then to On (lord help you if you flipped off both halves of the switch!). Many early 150/17X planes had an automatic resetting circuit breaker in the field circuit which was not explained by Cessna and often misrepresented in their circuits in the pilot's operating manuals. A fuller explanation of it is presented later.

The newest OVP versions are based on using an SCR instead of a relay and better filtering so as to avoid false alarms. Some of the external OVP's work this way: the voltage is sensed, really fast glitches

ignored, but when a pulse of a high enough voltage and duration comes along, the circuit reacts by putting a dead short in the field line causing the field circuit breaker to pop. Others have other methods to simply open the field circuit. Nobody seems to get the joke of having a secondary circuit to shut down the circuit (the regulator) which is supposed to protect against overvoltages in the first place. Today you can buy a slightly higher cost regulator with a built-in OVP; it lowers the field current until the overvoltage goes away. If there is a choice, opt for the regulator with the built in OVP.

A feature often overlooked is that Cessna, after the adoption of the alternator, has depended on the split master switch with one side controlling the battery solenoid and the other the field circuit of the generator or the alternator. That "second side" permitted the reset of the OVP without shocking the system by simultaneously also turning off and on the master. The double pole single throw master switches used on the 120/140/140A planes would not permit a reset without also recycling the entire electrical system by opening the master solenoid. That effect is a very bad idea and that is why I advocate the combination swithc/circuit breaker for the field, so you can leave the Master switch alone when resetting the alernator. If you turn the master off while the alternator is alting, you will be lucky if you only have to buy new fuses for your radios and transponder. Unless the battery is left in the system to absorb the alternator output, the alternator voltage goes up rapidly and drastically.

In a letter from Clifford Ives, the Cessna Service Engineer, '67 through '71 planes did not have the OVP but after 1971, all did. On the early planes with the OVP, it looks like an oversized ChapStick and later, they added a large capacitor to prevent the many false shutdowns.

Overvoltage, No Alternator Alert Lights:

If you want to see an exercise in confusion, go to the Usenet and search under the "overvoltage" title. Many! pilots believed they knew what the lights mean but found they mean different things on different years of planes; most had never seen them lit and had no idea if they worked. Some found that they could test by shutting off the alt switch and back on with the master on, others found that they should go on at startup and then go out. If you buy a system which includes an alert light, try very hard to find out how it is supposed to work. http://groups.google.com/groups?hl=en&lr=&ie=UTF-8&group=rec.aviation is the URL to find the alert light comments; when that page comes up, fill in 'alternator light'. They are "illuminating" to read and scary to find so few pilots who know what they do and how to make them do it. Searching for "overvoltage light" gives you the first 10 of 1,030. Cessna went from "High Voltage" to "Low Voltage" labels for the lights.

Shielded or not:

Cessna, in their progression through different models of the 150, kept adding filters and shielded wires, ending up with all the wiring in the alternator circuit shielded, including the size 8 output wire. Whether that was to diminish the noise which affected the Lorans and other low frequency electronics of the era, it seems not necessary today with the typical VHF radios and GPS's. If you have a Loran or a low frequency direction finding system, then you would be well served to use shielding. All sizes, including the size 8, are available from Spruce in shields. On a later page is a diagram of the newer system, with shields.

Grounds:

Follow the later Cessna pattern in grounding the engine to the firewall with a flexible cable (often made of shielding alone). Too often, the engine appears to have a very robust ground cable/braid, it being attached to the lower left mounting bolt, front and rear...neat, except all it does is connect the bolt to the bolt and nothing else since the bolt is insulated from the plane within a rubber mount. There is a ground post on the alternator to which the cable can be connected. Alternatively, there is a vertical stud at the lower left rear of the engine, often empty but sometimes used for an alternate 150 muffler brace. The ground cable needs to be at least as large, ampacity wise, as the alternator output cable.

Cooling ducts or not:

If the alternator you use is rigged with an inlet duct for cooling air, use it by connecting a SCAT tube to it and to a flange attached to the upper left baffling. SCAT and some very usable flanges are on page 120 of the 2003 Spruce catalog. Size is determined by the inlet duct of the alternator.

Things you need to change:

1. Ammeter to a 60-0-60 (Spruce)

2. Wire for the 60 amps. It doesn't matter if you intend to never use the unit for more than 30 amps...you must use the correct wire for the full output. The later 150's used shielded wire, available from Spruce.

3. Some regulators provide an indicator light circuit like the cars which show that the alternator is not yet providing an output....wire can be 22 gage for it and for the OVP alert light, if you have one.

4. Some circuits call for an OVP which comes in different packages, but a common feature is the use of a warning light. We like the mil-spec type indicator lamp which allows you to check the bulb by pressing its front; there is no way to check many of the Cessna-type circuit OVP lights. The use of the mil-spec checkable lamp requires another wire to power of course. If you use a regulator which permits testing the light, then nothing else is needed. One of the major STC's requires a voltmeter, a great option and advantage in that it also indicates the "health" of the battery before startup. Some take advantage of the opportunity and utilize a single meter which indicates both voltage and amperes.

5. Some regulators have a built-in OVP portion, probably the easiest solution because you need only wire to the indicator light, (not the same light as before...this one alerts you to the fact that the alternator needs to be reset by turning off and back on the field C/B = circuit breaker (usually)). Wire to the light can be 22 gage

6. Circuit breakers. Fuses should not be used for the alternator installation based on the limitations of the fuse and fuseholder manufacturers so plan on using circuit breakers. A circuit breaker can be reset in flight, whereas a fuse cannot and you can get a switchable circuit breaker of 50 amps size. The type and styles for the field circuit and for the total output give you some choices. The small breaker is easy, plenty of styles, but I like the switch type because it allows you to reset when you want to, whereas the type that cannot be pulled or manipulated until it pops is not my style. The output C/B is more limited with the only 60 I know of being the non-switchable, non-pullable type. Consequently, I chose the largest switchable unit, 50 Amps, so the two are a matched set, placed together. Note that you have to add the size wire which is correct for the 60 amps, regardless of whether you ever use that much current, but you do not have to use a circuit breaker of 60 amps.

Part of your writeup on the 337 is to measure the "normal current" of the plane and that sum should be less than 80 percent of the ampacity of your new system. Do make the measurements, do list them, and do the math yourself. A high priced FBO here was off by a factor of ten in his "estimation" of the current of the radios and made other expensive mistakes besides.

If you follow the AC 43 .13 rules, and you must because you are going to state you did on the 337 and/or the STC input...you are supposed to measure and tabulate the "constant" current requirements, those things always on such as the radio (s), solenoid, gyro (s), strobe (s), and so on, excluding things like the landing lights, <u>unless you leave it/them on all the time.</u> That sum is supposed to be no more than 80 percent of the sustaining capacity; that capacity is determined by the circuit breaker you utilize, not that of the 60 amp alternator unless you use a 60 amp circuit breaker. Usually, that 80 percent rule means you can be happy with a C/B smaller than the 60 amp size.

7. Often overlooked by mechs and owners are the requirements for diodes. There is a service bulletin to hook a diode across the coil of the battery solenoid for all Cessnas (wise, very wise, and cost about 25 cents) and one at the field control switch or the new switchable c/b for the field. Both diodes serve to kill the impulse of the coils of the solenoid and the field from getting to the bus and creating havoc on the radios.

8. The installation will affect the compass so put that on your list to recalibrate after the installation.

9. On some installations/STC's, a capacitor is called out for hookup near the regulator. Various capacitors (filters to Cessna) were used, depending on the year and the make of the alternator. Do not simply re-use

the generator filter which is on the firewall now. Some kits have immense capacitor filters to smooth the output, and others need a filter in the field circuit.

10. Noted before, you will need a regulator and there are several which can be used. See Spruce. The original units came with the same regulator as cars of the era, which means they included relays which wear out, but most new ones are based on solid state technology and work better and last longer.

11. Makers of intercoms and radios deny it vehemently, but some alternators induce noise (a whine) even though there is nothing wrong with them. You won't know until you run the units and the easiest fix is a filter in the line to the avionics (this is where your avionics master switch circuit is handy since it isolates the units). Don't fight it, just go to the Radio Shack Avionics section and get the ten Amp in-line filter for $16 or the 20 Amp unit and install it. On one plane with two Narco's, one repeated no howl but the other had a power supply which amplified it and fed it into the audio.

12. The wire sized for the alternator (8 gauge for the 60 amp unit is rated at 73 amps when routed individually) is not as limber as wires of that size of old because of the tighter twist of the strands and stiffer insulation. Something often overlooked but which makes life a lot! easier is to use two or three wires of smaller gage whose ampacity together is the same as the big one. And yes, you can put either two or three wires into the same lug/terminal which will be crimped. Legally. If the cross-sectional area of the several wires adds up to the same as the big wire, and it should if you select properly, crimp and go. From this chart from the AC43 new release, you can see that three size 12's or two size 10's are the equivalent to a size 8.

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

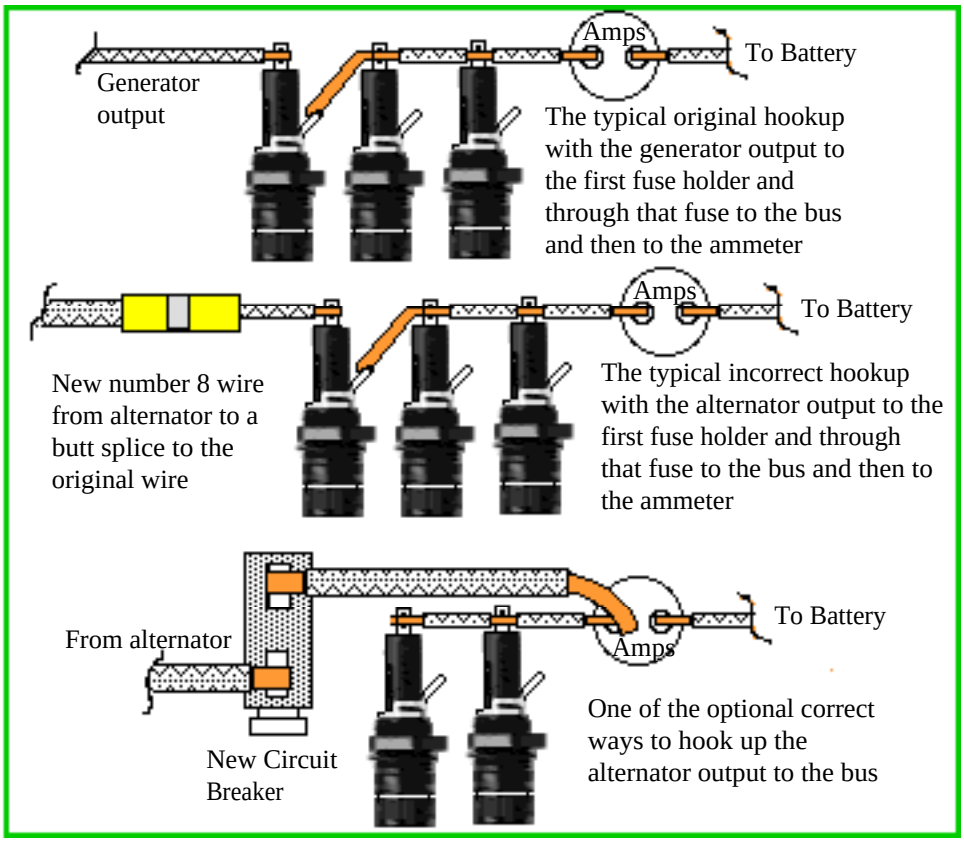
Gauge of wire	Routed singly, not in a bundle	Routed in a bundle
8	73	46
10	55	33
12	41	23

13. The original wire from the generator to the bus was sized so as to be able to handle the 35 amp generator and it runs from the output terminal of the generator to the first fuse of the string of fuses (the Gen fuse) and that same size wire is daisy-chained to the other fuses and then to the ammeter. The new 8 or 8-equivalent wire terminates at the new circuit breaker. Discuss what wire is run from the other side of the circuit breaker and to what. Discuss this with your A&X! Review the sketches later in the file.

Special, the auto resetting circuit breaker:

Many of the 150's and planes built at the same time as those are likely to have a Texas Instruments CA-X auto resetting circuit breaker in the generator field and then the alternator field circuit. Cessna changed the symbol for them from year to year, increased their ampacity, and sometimes identified what they do but more often did not. If you buy a used Cessna alternator package from a dismantler, make sure you get all of it, including the resettable circuit breaker if the plane had it (many do not know what they are and either split them away from the harness or neglect to remove them from their hiding place in a niche on the front side of the instrument panel). They look like this. Most of the first ones were CA-2, meaning they carried 2 amps, but later ones were of greater ampacity. If you get one with the alternator and harness from a 150/170/172, they will be okay. Expecting that you will find the wiring diagram for whatever used harness you get from a dismantler, pay attention to the ampacity of the CA part because Cessna upgraded to the CA-5 amp unit on later installations. They are still available from Texas Instruments and many dealers.

Hookups, right and wrong:



The top figure is how our planes were made, with the same size and type of wire from the generator to the generator output fuse holder also being the bus with periodically stripped wire soldered to the top terminals of the other fuses and that same wire continuing to the ammeter.

The second figure is how, too often, the alternator output is connected to the bus, with a new, "huge" wire butt spliced to the original wire as though the remaining old wire was now eligible to carry the increased current.

The third shows one of the ways to correctly accommodate the new wire and the higher current from the alternator.

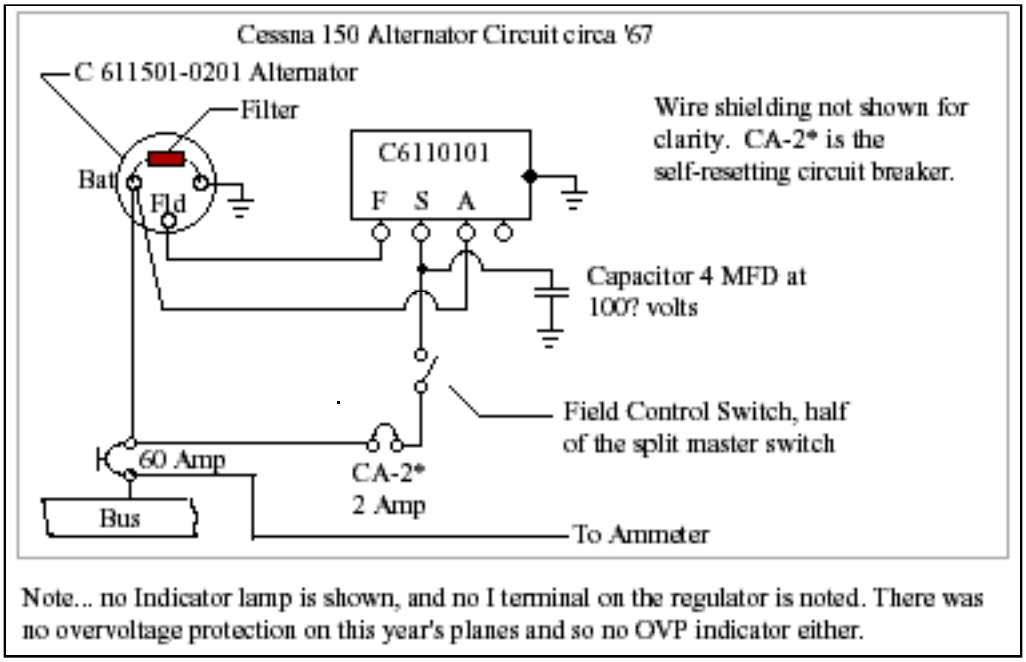
Be aware that, if the wire is hooked up to the wrong side of the ammeter, there will be no positive movement of the ammeter needle, but all the current to the bus will show as negative, all the time. One of our brethren was ordered to buy three new ammeters because "they were all bad" because of that hookup. With a sketch sent to him showing right from wrong, it was hallelujah time.

Stuff to buy or borrow:

STC? or not about $85
Alternator (maybe three Packets available..most use the Ford-made for planes) If you don't have a plane-approved core to send in for exchange, note that you pay more for the unit.
Regulator with or without OVP

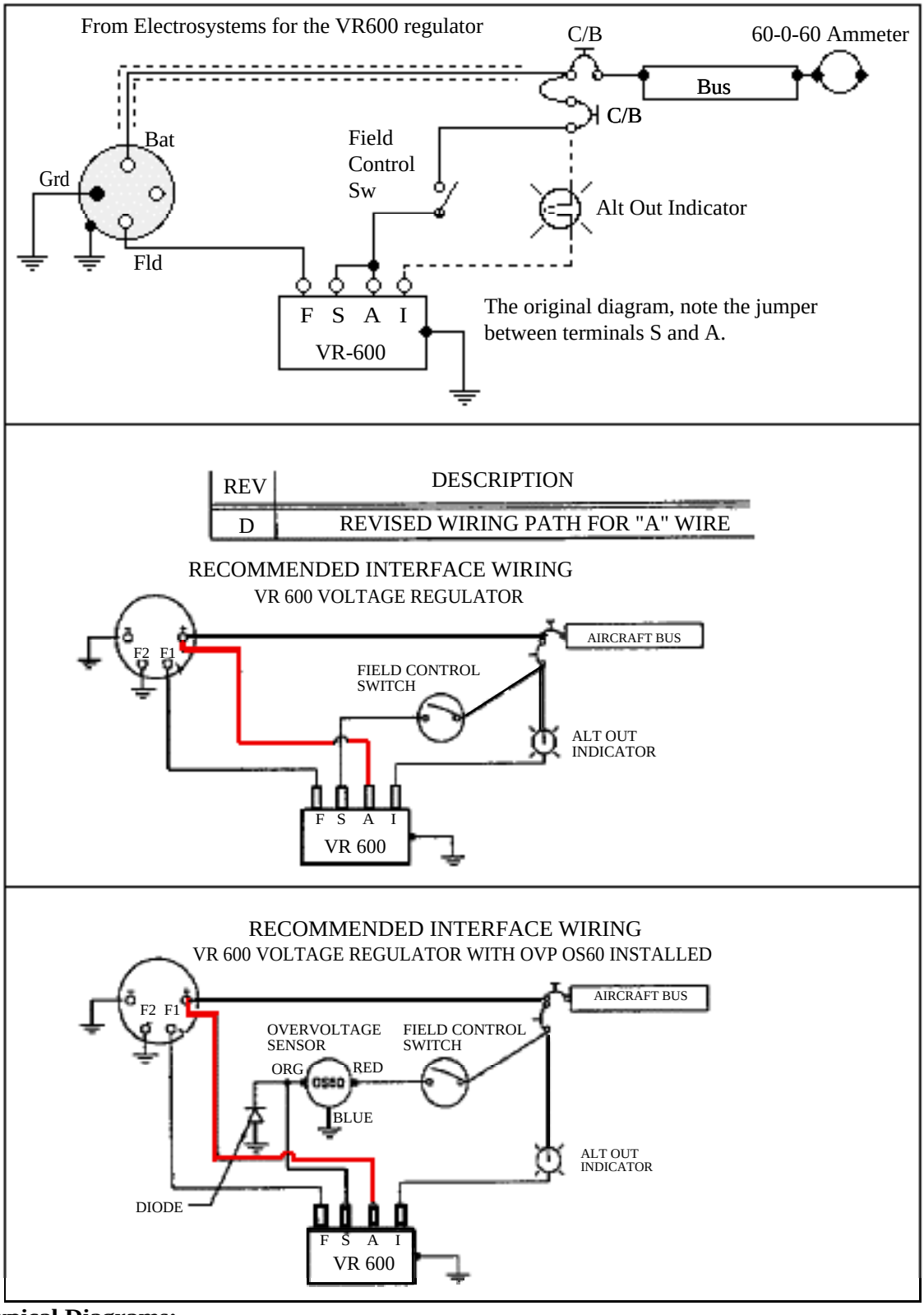
Indicator light (s) depending on the circuit and wiring diagram and regulator you purchase
Diode (s) as required by the circuit you select
Circuit breakers Alternator output (see text) and one for the field (five amps)
Wires...use two or three in parallel for the biggie if you like the ease of installation and 22 gage for the indicator lights and 18 for the field circuit and regulator wires (shielded or not as required)
Wire terminals, buy the best, with metal which extends to crimp over the wire insulation for support.
Gasket, a combo for the alternator and the tach drive housing (an extra is nice just in case)
New nuts, new washers for remounting both items (Careful, the threads on the alternator terminals are often not aircraft fineness but automotive type (10-24 versus 10-32 and so on)
Wire markers
Sta-straps (same as Ty-wraps) or approved harness lacing (or spot tie cord)
Crimpers and wire strippers
A resource to crimp the big lugs; an electrician is sometimes the best source for a crimper large enough.
The new drive line rubber cushions and holder (Spruce). See the service note for support.
SCAT tube and collar for a cooling vent if required

Circuits:
This is the circuit of the "first" Cessna 150 with the alternator.



The "I" terminal of the regulator is not ever marked on the first diagrams and there is no OVP circuit to be concerned with. Note the 4 MFD capacitor does not correct any noise being created and passed along to the alternator output; its purpose is to keep the "S" field current smooth. The red filter shown on the alternator is never defined as to size.

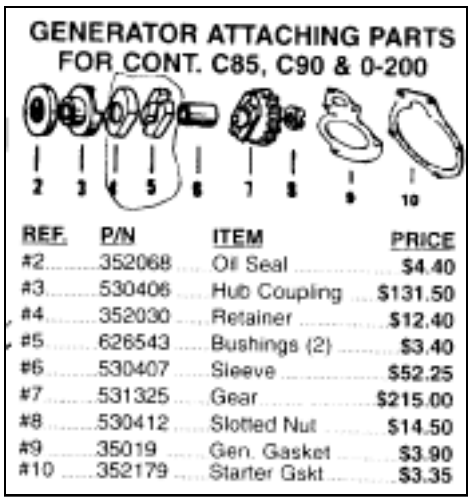
Fred Lagno's circuit on his STC (Barnstormers Inc) uses a voltmeter to monitor the goodness of the system, and his point is that it avoids the complexity of the OVP's and their problems and gives you the status of not just the alternator output, but the battery before firing up the engine. With the voltmeter and the ammeter, you can confirm operation as well as troubleshoot if that becomes necessary; handy to keep tabs on the "aging" of the battery. Again, if you are sure of approval, consider the single meter which shows both the voltage and the amps.



Typical Diagrams:

These three diagrams are 20? years beyond that of the first diagram from the ‘67 150, but not much has changed. The top figure of the three shows the diagram I got with the regulator and rebuilt alternator I bought from Electrodelta via Spruce. From the first time it was fired up, the alternator worked fine but

there was the "twitch" of the ammeter needle and the frustrating flickering of all the lights, including those of the radio and dimming of the radio lights when it was keyed....the symptoms made one wonder. Writing to Electrodelta yielded "the change" which had not, of course, been forwarded to prior customers. In the next two diagrams, I highlighted the wiring change which was the reason for the new version; the red wire was added and the jumper between terminals S and A of the original diagram was removed. What a difference!!! Not a twitch in the ammeter since the change was made.



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

The Parts String of the Alternator:

From a new catalog from Aircraft-Spruce, this table of parts for the generator. 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...the price from Continental? be sitting when you ask for it. The cotter key is one of the most important items in the parts stack so double and triple check its installation.

Removal and Re-installation:

Battery disconnected first. Remove the wires but label the wires of the generator before removing them, just in case, and put the nuts back on the generator terminals to protect the threads. Remove the regulator, marking those wires as to which terminal they attach (some are individually attached and some are attached via a formed block). This is "just in case" too.

Bite the bullet and remove the tach drive housing next. You will be buying a new gasket which is a combination gasket for both the gen/alt and the tach drive housing, so take it off. To do so makes the removal and installation of the new alternator so much easier, and that fact is attested to by many on the web sites.

Fill up the temporarily empty holes in the engine with huge clean rags (one of our brethren found that his oil pressure at startup problem was because one of the small paper towels he used was wrapped around the oil pump standpipe...for years). Make sure no one turns the prop or some of the hole filler will get chewed. Even better is to use the gasket as a pattern and make a cover for the hole from cardboard.

It is a temptation to make tightly wrapped and/or tightly strapped bundles of wires for neatness. Note that the current rating for the size 8 wire is for it being not bundled, but essentially run alone.

Weight and Balance:

The alternator weight must be known for the W&B, as must the weight and moment of the generator you are taking off...there are four sizes of generators which were used...and remember...the 140A's CG datum is different than that of the 120/140's!

Generator (eligible 12, 14 and 15 series only)	Weight (lb.)
Delco-Remy No. 1101876 (CMC P/N A40435) 12 v. 15 a.	10
Delco-Remy No. 1101890 (CMC P/N 534111) 12 v. 20 a.	10
Delco-Remy No. 1101879 (CMC P/N 530190) 12 v. 25 a.	14
Delco-Remy No. 1101898 (CMC P/N 536035) 12 v. 35 a.	16

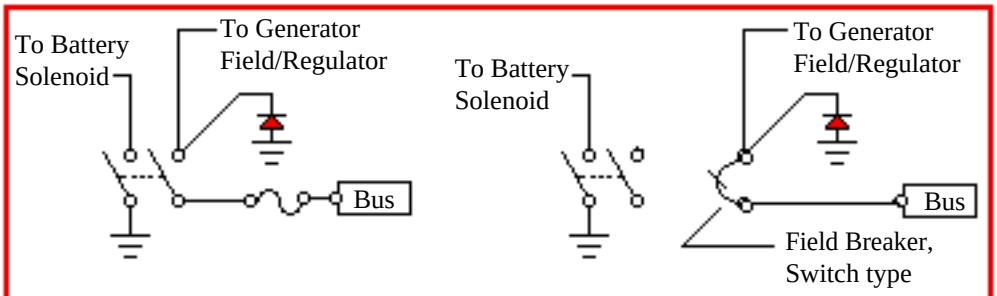
Things not to think about:

In many of the circuits I have seen for alternators, the small fuse or c/b for the field circuit is hooked to the big circuit breaker at the "output" side. Okay as long as everything works, but note that the "Alternator Out" light is powered by the field breaker, too. That means, if the big breaker pops or the little breaker

pops, the light you are depending on to tell you that interesting fact won't work!!! By design, bad design. There are those who have "inadvertently" hooked the field breaker to the bus and their ALT OUT light will work when the alt quits. If you need confirmation that the better hookup is acceptable, the Cessna later year diagrams show the field breaker is hooked independently to the bus, not through the output circuit breaker.

Switching and why:

Cessna split switches are notorious for developing a resistance with time and some water, and that causes things like alternator shutdowns via the OVP's or the twitching ammeter and flickering lights. If you read the recommended alternator source site information, you will note that all make the point that even two tenths of an ohm of resistance in the field power circuit will cause problems of shutdown or the infamous wiggling ammeter. My suggestion is to avoid using the Cessna split switch and avoid utilizing the half of the existing master switch which now controls the field circuit for the generator...use a separate switch for the field control and reset.



On the left, showing a typical Master Switch, double pole, single throw as on all the 120/140/140A's. The dotted line means both halves are ganged (like your master) and make or break together. On the right, one of the many alternate hookups, showing a switch type circuit breaker which allows resetting the alternator if you have an OVP of either type...without shutting off the battery.

Two tenths of an ohm is hard to find without a very good digital meter and some intense hunting. If you have the symptoms, first take off each terminal of the system in turn and clean it and take the grounds loose and clean those connections.

I wish I could recommend an Alt Out light circuit which is part of the packages available but I am not sure what some of them do or how. Incredible that the Radio Shack voltage display, consisting of a stack of 5 LED's which indicate under, on, and over voltage for just under ten dollars is not a part of all the systems for planes. If you want that presentation, the RS part plugs into the cigar lighter socket. Alternatively, there are a couple of bus sensors which indicate undervoltage. As the Barnstormer STC owner makes clear, the voltmeter which is part of his package is a great monitor. With it and the ammeter, you have all the information you want regarding the health and operation of the electrical system. Consider that if you are going the 337 route.

Final Admonishment:

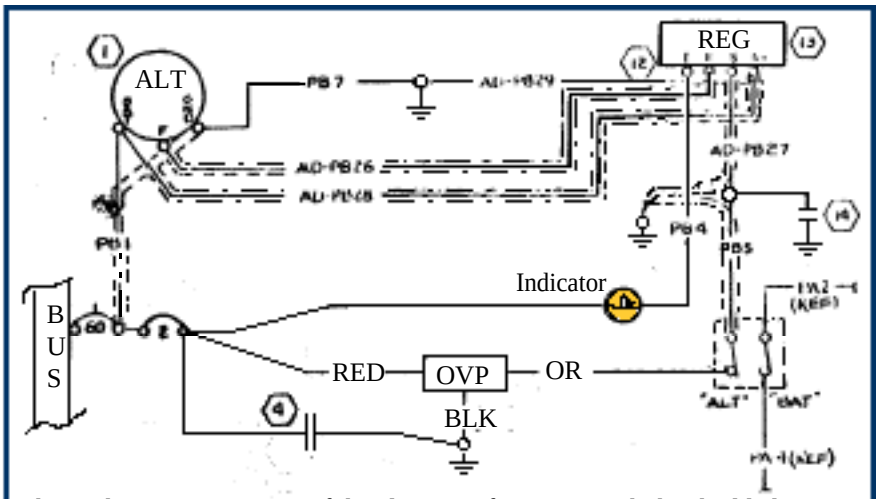
If you elect to use an STC, then you must do what it says with the parts it calls out; if it says shielded, so will it be. The other things described as a better way in this note cannot be used unless the A&X agrees. One must buy the STC to see what it says, so its limitations are not fully known. The one owned by Fred Lagno (Barnstormers Inc) and advertised in the Newsletter has recently been updated according to a message by Fred in the International site but not a hint as to what was done to change it. During your planning, be sure and discuss with your A&X what will be acceptable.

Bus:

"Bus" means: Common Carrier. An electrical bus is a common carrier. Buss means kiss. If you read the Zeftronics information on their regulators, you will see that some in the organization know how to spell bus and others do not. They also list the maximum field current as 5.0 amps on the first page and as 3.5 maximum on the other pages. Beware.

Cessna Newer Design:

Here is a much more recent Cessna diagram with the indicator lamp, the OVP, and the two capacitors and shielded wires. The item 4 capacitor, when it dries out, will cause OVP alerts so it should be replaced if you use a system from a dismantler. The infamous Cessna "split master switch" is shown here and I hope none of you feel obligated to use it. I cannot state how or when the indicator light works because it changed over the years. See if you can make it indicate something before depending on it; otherwise, you are carrying ballast. Note that this circuit uses the auto-resetting Klixon circuit breaker in the field circuit.



This is the next generation of the alternator for a 150, with the shielded wires called out, the OVP added along with the Indicator lamp, and the relatively huge (500 MFD) capacitor as item 4 to prevent spurious overvoltage shutdowns.

337 Examples:

I see request after request for "the 337's" to emulate as though they are magic, but the are not. Their creation is simple and straightforward. The following examples show what should not be done (these created by expensive "professionals") and what should be done and were done by people just like us. Realize that the FAA at the FSDO is not obligated to confirm anything and often does not check anything.

The front side of a 337 is for the identification of the plane, location, owner, and A&X signoff and, maybe, a tiny description of the work (...changed engine or...?) and the FAA blessing stamp.

The back side is where the good information is supposed to be. There are many variations and many deviations.

What works? A sketch of the wiring changes, a list of the parts used, and the parts removed, and any tests that were done to confirm conformance. And, of course, mention that the work was done per AC43.13b.

This is example One:

Read carefully because it was a big lie, and nearly killed the owner.

Replace the original generator with a Cessna 150 alternator.
Remove Delco-Remy generator, 12 volt, 12 amp.
Remove Delco-Remy regulator, 12 volt.
Install:

Part Name	Part Number
Alternator, 12 Volt, 60 Amps	C611501-0204
Regulator 12 Volt	C611001-0101 (actual was 0201)

Filter capacitor	0770038-2 (4MFD at 100 volts)
Diode assembly	S1629-1
Noise Filter	4MFD at 100 volts
Circuit Breaker (bus 35 amp.)	
Circuit Breaker (Field 5 amp)	
Wire, 8 gauge shielded	
Aircraft Power Required	**Amps**
Battery solenoid	0.8
navigation lights	5.6
Turn and Slip	0.2
Instrument lights	0.3
Compass light	0.08
Nav Receiver	0.45
Comm Receive	0.65
Comm Transmit	4.5
Anti-collision light	2.5
Electric clock	Negligible
Full Maximum Load	15.08

The following items were found to have the same specifications or part numbers between Continental engines C-85 and O-200A; generator armature drive to crankshaft ratio 2.035/1, generator armature drive direction CCW, Max Continuous torque for mounting pad for generator 60 in-lbs, Max static torque for mounting pad for generator 600 in-lbs, Max overhang moment for mounting pad for generator 100 in-lbs. Generator drive gear, bolted to camshaft, P/N 530535. Generator Mounting studs 5/16 X 1-3/8ths P/N 21463.

ME: Sounds efficient, truthful, and precise, right? Here is reality.
There was no "electric" clock
There were two radios, tube type and a tube receiver was usually 4 plus amps and transmit was 8 plus.
There are three instrument lights, each requiring 0.3 for a sum of 1.0 amp
Turn and slip was about 2 amps
He had no compass light.
THE CIRCUIT BREAKER ACTUALLY INSTALLED WAS 30 AMPS!!
There was only one filter capacitor, though two are listed.
There was no shielding on the 8 gauge wire.
Of the items listed, the true usage listings are for the battery solenoid, the nav lights, and the strobe light.
There was no electrical sketch given to the owner nor one attached to the 337.
There was no actual current measurement made by the FBO or mech.
There was no weight and balance effect mentioned, though required by the FAA rules (and "assumed" to be in the right place...see the fine print at the top of the 337 form page two)

AFTER two electrical failures while in clouds on instruments, and some troubleshooting by amateurs, it was determined that the **ACTUAL LOAD WAS 34 AMPS**!! Guaranteed to fail the 30 Amp C/B!

Let's see. He bought what he thought was a 60 amp system but what he got was a 30 amp system, for a price that would equate today of about $3,000, by the "best FBO" in the area. And yes, his circuit was the one where the big 8? new wire was butt spliced to the original size 12 wire at the bus. That trick is not sanctioned anywhere.

Yes, the FAA acceptance stamp is on the front; they simply record and pass along and have no responsibility of "checking" or verifying workmanship or procedures. Responsibility is the FBO's and the

installing mechanic's; the 337 was most likely done in the office, based on memory of prior incorrect jobs or guesses, without ever seeing the airplane.

Example two, page two:

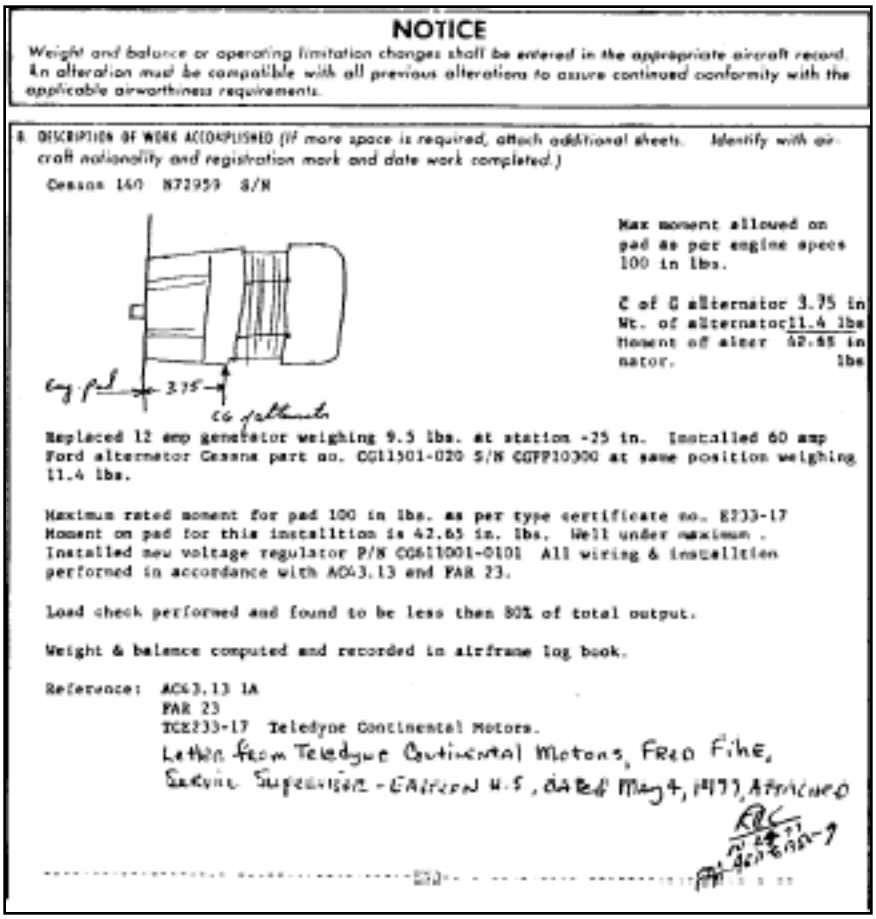
Removed 25 amp generator and related components. Installed 60 amp alternator C-611501-0203 8 AWG cable MIL W1684D3 3,000 volt High Temp wire braid shield, ALT to Ckt BKR.
CKT BKR 40 amp Wood 109-240-101
Regulator C-611001-0201; Plug and harness Assy 1250211-4; Filter 070038-2; 60 amp ammeter USBear Aeronautics; Fuse: Field ckt 2 amp; Master switch split section BAT & ALT. Form 337 and ckt diagrams filed herewith per AC 43.12-1&2. Tach 944

(author..Yes, that is all but they invoked AC 43, so that makes it all okay. 3000 volt shielded wire would be HUGE...300 volt wire meant.)

Example Three:

And here is the 337 submitted by John Hall, one of the pioneers of changing to the alternator and the one who advised so many by way of presenting his efforts in the International 120-140 Assn. Newsletter.

He/they did an actual load check, listed the weights and moments, and showed a sketch of the cg of the alternator. The wiring diagram was included. The handwritten note at the bottom states that a copy of the authorization to use the alternator from Continental was part of the package.



NOTICE

Weight and balance or operating limitation changes shall be entered in the appropriate aircraft record. An alteration must be compatible with all previous alterations to assure continued conformity with the applicable airworthiness requirements.

8. DESCRIPTION OF WORK ACCOMPLISHED (*If more space is required, attach additional sheets. Identify with aircraft nationality and registration mark and date work completed.*)

Cessna 140 872959 S/N

Max moment allowed on pad as per engine specs 100 in lbs.

C of G alternator 3.75 in
Wt. of alternator 11.4 lbs
Moment of alter nator. 42.65 in lbs

cg pad 3.75 cg of alternator

Replaced 12 amp generator weighing 9.5 lbs. at station -25 in. Installed 60 amp Ford alternator Cessna part no. CG11501-020 S/N CGFF10300 at same position weighing 11.4 lbs.

Maximum rated moment for pad 100 in lbs. as per type certificate no. 8233-17
Moment on pad for this installtion is 42.65 in. lbs. Well under maximum.
Installed new voltage regulator P/N CG611001-0101 All wiring & installtion performed in accordance with AC43.13 and FAR 23.

Load check performed and found to be less then 80% of total output.

Weight & balance computed and recorded in airframe log book.

Reference: AC43.13 1A
FAR 23
TCE233-17 Teledyne Continental Motors.
Letter from Teledyne Continental Motors, Fred Fihe, Service Supervisor - Caribou W.S., dated May 4, 1977, Attached

Neat, concise, correct, and complete.

Tidbits:

A lot of people mis-understand the purpose of the diode shown to the left of the OVP; it is to dampen the surges caused by the shutdown of the field current. The regulator shuts off and turns on various widths (in time, the voltage is always the bus voltage) of current to the field to control the output voltage/current, so the field is being shut down many times a second. Without the diode, the circuitry inside the OVP is at risk, and you would likely get many false OVP indications and shutdowns. It looks "backwards" but it is only used to shunt "backwards" pulses, not the constant voltage at the OVP. Use it.

Note, too, that the "customary" large capacitor which was connected to the Field terminal of the regulators used with the generators of our engines is not used in conjunction with the new-style electronic alternators, the VR600 being of that type. The older Cessnas with alternators often had a large capacitor hooked to the S terminal just as for the generator. For a couple of years, they used a big capacitor at terminal S and a huge one inline from the output to the bus. Later still another capacitor was in parallel with the OVP. Do not assume, with the new circuits and electronic regulators, that to "add a couple" capacitors is a good thing to do. Also, do not mix the combination of parts for the various designs of the different makers.

The I terminal and the OVP:

Up until '72, Cessna did not use the I (Indicator) terminal, but after '72, Cessnas used and now use the I terminal when the OVP package was installed. When considering the I terminal, think "idiot light" as it was on cars of a greater vintage. Recall that the light was on when the switch went on, but went off as soon as the engine and alternator started. When running, the idiot light being on meant that your alternator was no longer working.

The OVP package has a voltage sensor in it, set to trip at 16 or 16.2 volts (and compensated on the new ones for temperature). If the voltage exceeds the trip point for the preset duration, a "latch" circuit is enabled, and that causes the device through which the field current goes to be forced to open, so there is no field current to the alternator. At that time, the OVP light on the panel should be illuminated. The Cessnas using alternators were made with a split master switch, half of it being to add a ground to the battery solenoid, closing it, and the other half as the alternator control by shutting off or turning on the Field current path before the regulator. When the OVP circuit is included on the plane, it is re-activated following an OVP shutdown of the alternator by turning the alternator half of the master switch off and back on. That releases the latch and the device which broke the circuit so as to allow current to flow again to the regulator and through it to the field.

Cessna says (on some planes) that one can test that the OVP lamp is "good" by turning on the master, turning off the alternator half of the circuit and then turning it on again. The Cessna master switch is made such that both sides can be turned on as one, so the alternator half can be turned off and on without affecting the battery solenoid half, and so that turning off the solenoid half forces the alternator half to go with it.

A caution. NEVER turn off the whole master switch when the alternator is creating an output!! First, turn off the electronics, stop the engine and then turn off the Master and ignition. Be careful because leaving the electronics on when you turn off the master without first turning off the alternator field can cause damage to the electronics because the "current sink", the battery, needs to stay connected to absorb the energy.

No matter how many times this is stated, there are those who defy good reason and insist to the unknowing that the existing wire from the generator to the bus is adequate for a 60 amp alternator installation. It is NOT!. The wire that came on the planes to serve as the bus and the generator to bus cable is size 12 and if you look back at the FAA's AC43 table in this article, you will see that size 12 is good for up to 41 amps on a continuous basis if run independently by itself and not tightly bundled. The wire from the alternator to the bus must be capable of the whole 60 amps!! No exceptions, no "figuring" that all those amps will never be used...they will...and so the little wire ought to be enough. It is not. Be safe, use the correct size.

Neal F. Wright
cougarnfw@aol.com revised 20 July ‘05 title: Alternator Considerations

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