CRAFTSMAN'S CORNER

Ben Owen

ELECTRICAL SYSTEMS . . . DOLLARS AND POUNDS

We have endeavored to put together a basic electrical system using various catalogs and advertisers information.

BASIC SYSTEM

ITEM	WEIGHT	COST
B&C Starter with Solenoid	10 lbs., 3 oz.	$ 550.00
Alternator - Nippondenso (Honda) kit	8 lbs.	260.00
Adjustable Voltage Regulator	1 lbs.	40.00
Over Voltage Relay	1 lbs.	60.00
24 Amp B&C Battery, including shipping	18 lbs., 8 oz.	92.00
Battery Case	3 lbs.	69.50
Bus Bar from the Electric Store	1 lbs.	5.00
Ammeter	1 lbs.	6.25
Alternator Field Switch	0 lbs., 1 oz.	6.95
Master Switch	0 lbs., 1 oz.	6.95
Master Relay	1 lbs.	16.60
Circuit Breakers (7 @ $7.00)	0 lbs., 7 oz.	49.00
Wires, Tie Wraps, Etc.	5 lbs.	40.00
TOTAL	50 lbs., 4 oz.	$1,202.25

BASIC VFR RADIOS

ITEM	WEIGHT	COST
Bendix 14 Volt KY 97A, 760 Channel	2 lbs., 15 oz.	$1,090.00
AT 150 Transponder	2 lbs.	694.50
Mode C by ACK	0 lbs., 8 oz.	299.00
VHF Broadband Antenna	0 lbs., 7 oz.	53.50
Transponder Antennae	0 lbs., 2 oz.	27.50
Cords, Connectors	0 lbs., 10 oz.	35.00
Headsets - Hush A Com x 2	3 lbs.	339.00
a. Power Cord	0 lbs., 2 oz.	12.00
b. 2 Push-to-Talk Switches @ $29	0 lbs., 4 oz.	38.00
ELT EBC-10A	1 lbs.	299.50
TOTAL	11 lbs.	$2,888.00

VFR CROSS COUNTRY ADD-ONS

ITEM	WEIGHT	COST
Add Nav Potential to Communications	2 lbs., 2 oz.	$ 650.00
Loran	4 lbs.	659.00
2 Circuit Breakers @ $8.95	0 lbs., 2 oz.	17.90
TOTAL	6 lbs., 4 oz.	$1,326.90

BASIC NIGHT FLYING ADD-ONS

ITEM	WEIGHT	COST
Wing Tip Lights x 2	0 lbs., 6 oz.	$ 105.00
Red and White Strobe Light	1 lbs.	109.00
Tail Light	0 lbs., 3 oz.	25.75
Instrument Post Light	0 lbs., 4 oz.	99.50
Wiring, etc.	0 lbs., 8 oz.	15.00
TOTAL	2 lbs., 5 oz.	$ 354.25

ELECTRICAL BASIC ITEMS TOTALS

ITEM	WEIGHT	COST
Basic Electrical System	50 lbs., 4 oz.	$1,202.25
Radios	11 lbs.	2,888.00
Navigation and Cross Country Add-Ons	6 lbs. 4 oz.	1,326.90
Night Lights	2 lbs., 5 oz.	354.25
TOTAL	69 lbs., 13 oz.	$5,771.40

The basic electrical system uses many lightweight items - some that might be somewhat more expensive than slightly heavier items. It is the builders decision at this point whether he wants to pay more or weigh more. The B&C alternator is of low output, but so far has been quite successful in aircraft such as the Long-EZ without excessive demands on its 12 amp system. A typical Long-EZ installation includes a Navcom, a loran and a transponder without Mode C. Use of an ultralight weight alternator may require electrical management and turning off some of the items when using others. What type of alternator to buy is totally up to the builder, who should sit down and figure out his amperage requirements and determine if he can, in fact, turn some items off while others are being used. The small and lightweight B&C alternator has been very acceptable to many aerobatic pilots also. So far, none of the B&C users have required the 13.8 volt charger, but it is a must use if either of B&C's batteries, the 24 or 32 amp, are ground charged, because U. S. chargers won't work on those batteries. Other batteries are somewhat heavier. A linear voltage regulator is a new item from B&C that helps eliminate loran noise.

Most amateur builders use the 12 volt over the 24 volt system, as it is the cheapest, most available and lightest. The Bosch and so called "Honda" alternators are also excellent lightweight choices.

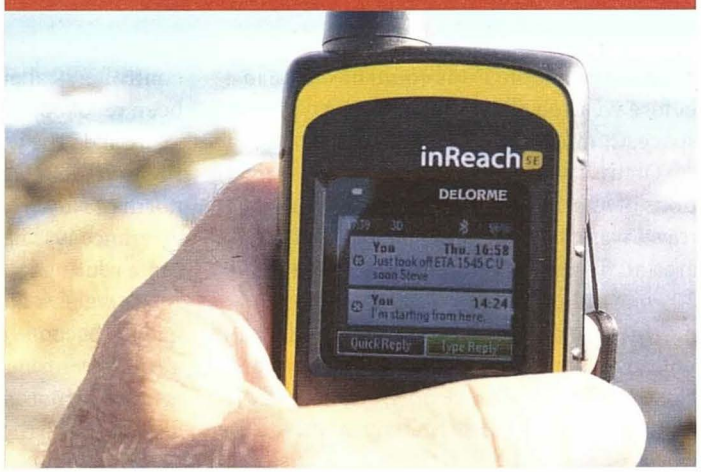
Maximum continuous amperage is 80% of alternator output. The simplistic design approach is to leave all electrical items on to determine the amperage, and select an alternator using 80% of the alternator output as the criteria. One excellent suggestion is to use switches capable of **DC output** in the range you need. DC switches are considerably stouter. It may also be possible to eliminate the master relay if the master switch is indeed capable of taking the entire bus bar amperage.

Tony Bingelis has written some excellent articles on electrical systems for SPORT AVIATION. The following may be issues in your library, or you may be interested in purchasing them from EAA:

Wire Installation (fuses), 7/84, p. 42.
Useful Electric Wiring Details, 9/84, p. 27.
Landing and Taxi Lights, 10/84, p. 29.
Switches, Part 1, 10/85, p. 23.
Switches, Part II, 11/85, p. 54.
Switches, Part III, 12/85, p. 57.
Minimizing Battery Problems, 1/87, p. 35.
Wiring Practices (fuses, wires, etc.), 7/88, p. 27.

EAA does not specifically recommend any manufacturer or supplier over another. Please use the foregoing as an example only.

STEVE ELLS
COMMENTARY / THE WORKBENCH



Where You At?

In the event of an unplanned inadvertent off-airport landing

THE ODDS ARE VERY SMALL that you or any other EAA member will ever need to be found and rescued following what can politely be called an unplanned inadvertent off-airport landing (UIOAL).

Very small indeed. Reports from the National Oceanic and Atmospheric Administration (NOAA) show that emergency locator transmitter (ELT) signals picked up by the Search and Rescue Satellite Aided Tracking (SARSAT) system resulted in the rescue of 240 people in 2014 and 135 people so far in 2015. The majority of these are rescues at sea and hikers; only 15 in 2014 and 12 so far in 2015 are cited as aviation rescues. Small numbers, but you can bet big money that those rescued were overjoyed when help arrived.

NOAA statistics also reveal that adoption of the modern 406 MHz ELT is not as widespread as was hoped, and that the incidence of false alarms is still alarmingly high.

As of June 2015 the total number of aviation 406 MHz ELTs registered totaled 81,721. The *2014 General Aviation Statistical Databook* published by the General Aviation Manufacturers Association (GAMA) estimated there are more than 199,000 active GA aircraft in the United States.

So it appears only four out of every 10 registered aircraft are equipped with a modern 406 MHz ELT. I'm sure everyone is aware that the old 121.5 MHz ELT signals are no longer detected by the SARSAT system. Even though the SARSAT constellation no longer is tuned to receive the 121.5 MHz signals from older ELTs, all 406 MHz ELTs also broadcast a 121.5 MHz signal used by searchers to pinpoint crash locations.

A 406 MHz data burst signal is picked up instantly; location definition depends on the equipment. The SARSAT system can locate a 406 MHz ELT data burst without GPS location coordinates to a radius of 2.3 miles by using Doppler shift procedures that depend on a sequence of satellite passes. The process takes at least an hour. If the 406 MHz ELT signal is paired with GPS-derived coordinates, the crash location is centered on a 100-meter radius signal and will be relayed to SAR headquarters within 10 minutes.

406 MHz ELTs are vastly superior to 121.5 MHz ELTs in every way. Broadcast power is many times greater, and ELT location detection is much more definitive. In spite of its superiority, there's no legal mandate to install one. It's perfectly legal to fly along with a 121.5 MHz ELT.

The 406 MHz false alarm frequency is not as bad as the 121.5 MHz ELTs, but it's still pretty dismal. Data requested from SAR headquarters showed that 6,372 alerts were detected in 2014; only 89 were actual distress alerts. The rest, 6,283 or 98.6 percent, were false reports. Fifty-seven percent of the false reports were due to improper testing (do you know how to test and how often to test your 406 MHz ELT?) and poor maintenance practices.

All 406 MHz devices must be registered to maximize SAR capabilities. Registration is required by law and must be updated

PHOTOGRAPHY COURTESY OF STEVE ELLS

every two years. Registration forms identify the owner and include an address, the type of aircraft (single-engine, multiengine), size of aircraft and make, model, and color of aircraft, as well as a list of personal and business contacts.

Up-to-date personal and business contact phone numbers aid SAR teams in gleaning additional information and detecting false alarms prior to launching a SAR mission. SAR teams include federal and state organizations. Here in San Luis Obispo County, California, SAR teams are staffed by volunteers under the sheriff's office. One well-known resource consists of the flying and ground-based staff and volunteers of the Civil Air Patrol (CAP). One SAR command center cites CAP as its number one resource, although the military may assist in SAR missions if its primary mission is not compromised.

Given that the majority of personal aviation fliers have not yet installed 406 MHz ELTs, are these fliers simply out of luck in the event of a UIOAL? Nope. The least expensive and often overlooked locator is the cellphone.

MOBILE PHONE LOCATION SERVICES

With the proliferation of cellphone coverage, there aren't many places left in the United States with zero cellular coverage. Both the Apple iOS and Android stores show numerous of phone-locating apps. In addition, a quick Internet search revealed dozens of third-party phone finder and phone tracker apps such as Prey, Lookout, Avast, and ZoeMob that advertise the ability to track and locate cellphones. Add cellphone charging to your preflight checklist and make sure someone on your contacts list knows your cellphone number.

FLIGHT FOLLOWING

IFR flights can be tracked in near real time on the FlightAware

website. Sometimes the flight tracks of VFR flights receiving flight-following services are also displayed but not always. I've been told the sure way to ensure every leg of a VFR flight is displayed is to file an IFR flight plan—which gets the airplane N number into the ATC system—and ask for flight following without opening the flight plan.

PORTABLE LOCATION DEVICES

Non-aviation portable devices are relatively inexpensive and readily available. The devices, which transmit emergency location signals to satellite networks, fall into two categories: personal locator beacons (PLBs) and satellite messengers. Both derive location information from the SARSAT networks and send messages and tracking information through the Iridium or Globalstar satellite networks.

THE 406 MHZ ELT RESPONSE

When an SOS signal from a 406 MHz ELT is detected, its location is transmitted to a network of ground stations before being relayed on to the U.S. Mission Control Center (USMCC) in Suitland, Maryland. The USMCC processes the distress signal and coordinates with the Air Force Rescue Coordination Center (AFRCC) before alerting search and rescue authorities. When the owner of a PLB or a satellite messenger pushes the SOS button, different networks jump to respond.

GEOS ALLIANCE RESPONSE

When a PLB or satellite messenger user pushes his or her SOS button, a signal is relayed to the GEOS Alliance International Emergency Response Coordination Center (IERCC) near Houston, Texas. The IERCC first attempts to contact the owner of the device by cellphone to gather details about the emergency. Second, the phone numbers the owner previously entered on the device registration are called to gather additional information to help determine if the SOS is a true emergency. If IERCC determines help is needed, it contacts the emergency response team nearest the location of the radiated signal with the information needed to start an emergency response.

The GEOS alliance also offers additional prepaid membership plans. These include the SAR50, which provides $100,000 ($50,000 per incident) per year to fund the cost of SAR efforts almost anywhere around the world. The new SAR100 plan provides $100,000 of coverage for a single incident. These plans are surprisingly affordable and provide funds to hire additional SAR providers in the event the local providers are unable to mount a timely search effort. They are especially valuable when flying in countries with spotty SAR resources.

PLBS

The most common PLBs are small, light, and weather resistant and are manufactured by ACR Electronics. These include the ResQLink, the ResQLink+, the AquaLink, and the AquaLink View models. These range in price from around $260 to $400 depending on the model.

One important caveat when using a PLB: It must have a clear view of the sky to send that SOS signal.

SATELLITE MESSENGERS

Satellite messengers get their location data from the SARSAT network. The messaging capabilities depend on other satellite arrays. Units by DeLorme use the Iridium satellite network for messaging, while SPOT messengers use the Globalstar satellite network. Both Iridium and Globalstar are capable satellite networks providing near-worldwide coverage. For more detailed coverage information check each company's website.

Both devices require users to purchase a service account for access to its system. DeLorme has a number of accounts to fit a wide range of users.

One of the best features of the DeLorme units for aviators is the Automatic Flight Following and Ping-Me Locating service. The DeLorme SE and the DeLorme Explorer can also be used to send and receive 160 character text and e-mail messages, track movement progress, and send messages and updates to social media such as Facebook and Twitter. During initial setup, message recipients' addresses and short pre-selected messages such as "Just took off" or "Just landed" can be added to a message database.

For what it's worth, the DeLorme website claims the most common text message sent from its portable messengers is "I love you."

The SPOT 3 is the latest iteration of Globalstar's messenger. SPOT messaging is limited to sending (via e-mail and text) prewritten messages or "check-in" messages to a maximum of 10 contacts. There's also an "Assist" message that is sent when non-emergency help is needed.

Launched in 2007, the company website claims SPOT devices have already affected more than 3,000 rescues. Like all the devices mentioned in this article, SPOT must have an unobstructed view of the sky for reliable results.

The initial cost of the SPOT 3 unit is very reasonable (less than $100). Annual subscriptions (there's only one size) run about $150 a year. This fee includes SOS notifications, messaging, and Basic SPOT Tracking, which sends position updates to Google Maps every 10 minutes. Unlimited and Extreme Tracking programs add more options to tracking such as position reporting at selected intervals (every 2-1/2, 5, 10, 30, or 60 minutes).

Spidertracks also makes a satellite messenger, but it's designed to be an aircraft tracking device for fleet operators tracking airplane movements and times. If a disruption of normal operations is detected, it automatically sends a location message to contact list addresses.

Today there is a large selection of flight tracking and emergency alerting tools that can be used in the unlikely event of a UIOAL. Few pilots believe it will happen to them, but it can, and if it does, the pilot who carries a fully charged cellphone, PLB, or satellite messenger has taken steps to up the odds of getting rescued sooner. EAA

Steven Ells, EAA 883967, is an A&P mechanic, commercial pilot, and freelance writer. He flies a Piper Comanche and lives in Paso Robles, California.

A COMPUTERIZED INSTRUMENT PANEL

By ED WISCHMEYER
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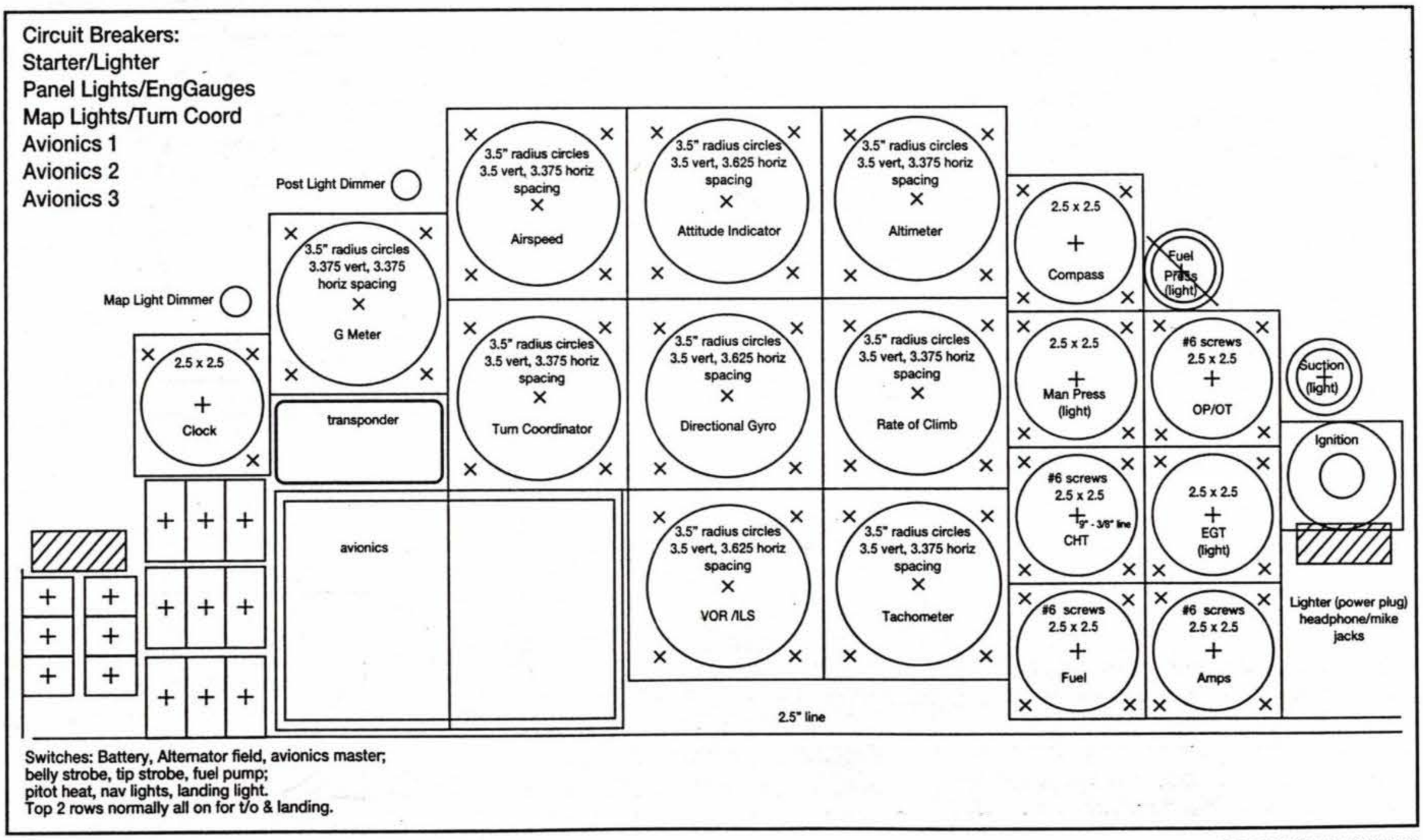
After my friendly neighborhood mechanic stuck a jack through the wing of my newly purchased RV-4, I decided to redo the instrument panel while the plane was apart, so that I could practice ILSes without having to rent a spam can. This meant that the RV-4 panel was going to be stuffed to the gills, and it would be a real challenge to design a functional, pleasing panel.

Since I work for Apple Computer, it seemed appropriate to see if I could find a simple, inexpensive way to lay out the panel on my Macintosh, especially if I could do it with standard, inexpensive software, rather than a fancy CAD/CAM package. I wanted to explore different panel designs and choose which instruments to buy (a 2" or 3" G-meter? 2" or 3" manifold pressure?), and to print out a final, full size copy with all holes marked for centerpunching. I used inexpensive MacDraw II from Claris Corporation, but there are alternatives on the Macintosh and on those other machines.

The first step is to make templates for each size of instrument. MacDraw lets you use a grid, so that everything you draw is constrained to the grid. With the grid set to 1/8", lay out the hole patterns for a 3-1/8" instrument, putting in a little cross for each hole. Since the hole spacings are in nice round numbers from the center of the instrument, it's a lot easier to lay out the hole pattern vertically (Figure 1), select all of the crosses together, group them into one element, and then rotate the group 45 degrees to the standard orientation (Figure 2). Next, draw a circle 3-1/8" in diameter, and then draw a box 3-1/2" on a size, or whatever size you choose. This box will reserve blank space around the instrument hole for the instrument itself and for the space required between the instrument. Command the box, circle, and hole pattern to align themselves, left/right and top/bottom and group them together (Figure 3).

Voila! You now have a standard size instrument template which you can duplicate for each instrument. On each copy, put the name of the instrument and group the name with that template. You can include the screw sizes for all of the holes, and for those instruments which only require 3 mounting screws instead of 4, you can make that be part of the instrument template.

Do the same for 2-1/4" instruments, for avionics, circuit breakers, switches, a jack for tape recording your conversations with ATC (for protection against FAA enforcement excesses, which hopefully are behind us now), ignition switches, and everything else that seems to want to reside on your panel (Figure 4). On your templates, you can also draw the space required behind the panel



Switches: Battery, Alternator field, avionics master;
belly strobe, tip strobe, fuel pump;
pitot heat, nav lights, landing light.
Top 2 rows normally all on for t/o & landing.

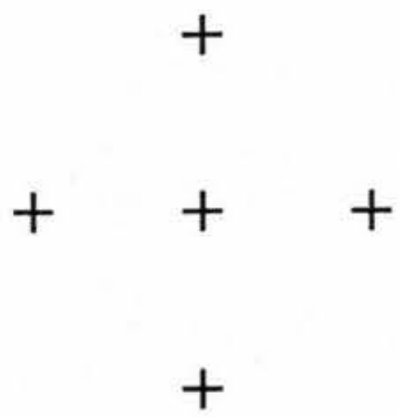


Figure 1. Instrument mounting holes, rotated 45°.

Figure 2. Instrument mounting holes, normal orientation.

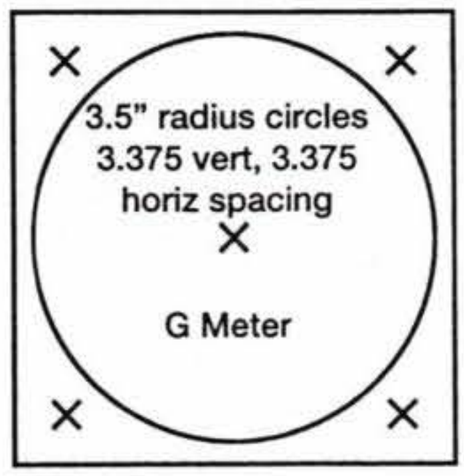


Figure 3. Completed Instrument template.

by each item, so that you don't lay out something where it won't fit. For example, the ignition switch has a small panel requirement, but requires a lot of space behind the panel. You can also draw in aircraft structural pieces that will obstruct space behind the panel. (I didn't leave enough room between circuit breakers for wiring, although I thought I did, so don't count on the computer to do your thinking for you!)

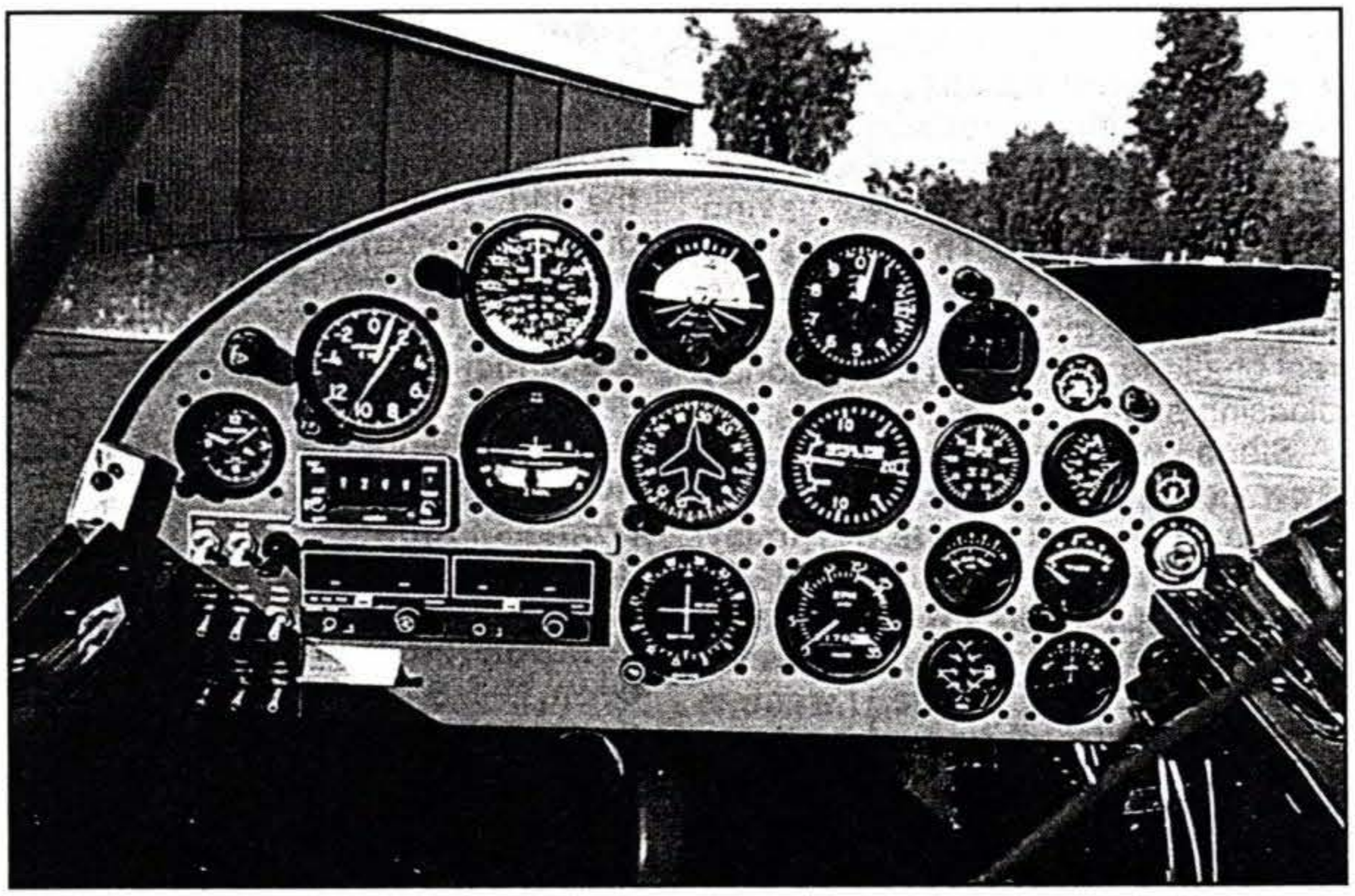
You can also write down the screw sizes for all of the holes, and for those instruments which only require 3 mounting screws instead of 4, you can make that be part of the instrument template.

Once you have a collection of outlines, you can try many different configurations of panel layout very quickly to find one that works best for you. By using the grid feature, the instrument layouts will align themselves to the nearest 1/8" (or whatever increment you select), and snap into place. This means that you don't have to do any tedious tweaking, fiddling, or fine alignment of your layout. The computer is a lot faster, easier and more precise than cardboard.

With the computer, you can also try various switch layout and combinations. For example, on my panel all of the switches accessed in flight are on the left, except for instrument knobs like EGT cylinder select and altimeter setting. (The ignition switch is on the right so I can keep my left hand on the throttle when starting.) The top two rows of toggle switches are normally on for takeoff and landing. Or you might prefer to place switches in a Cessna standard arrangement.

I probably tried 30 layouts to get one that I could live with, yet all of these trial layouts were done very quickly with every precise spacing.

When time comes to print out your panel, beg, borrow or steal a LaserWriter. You probably know



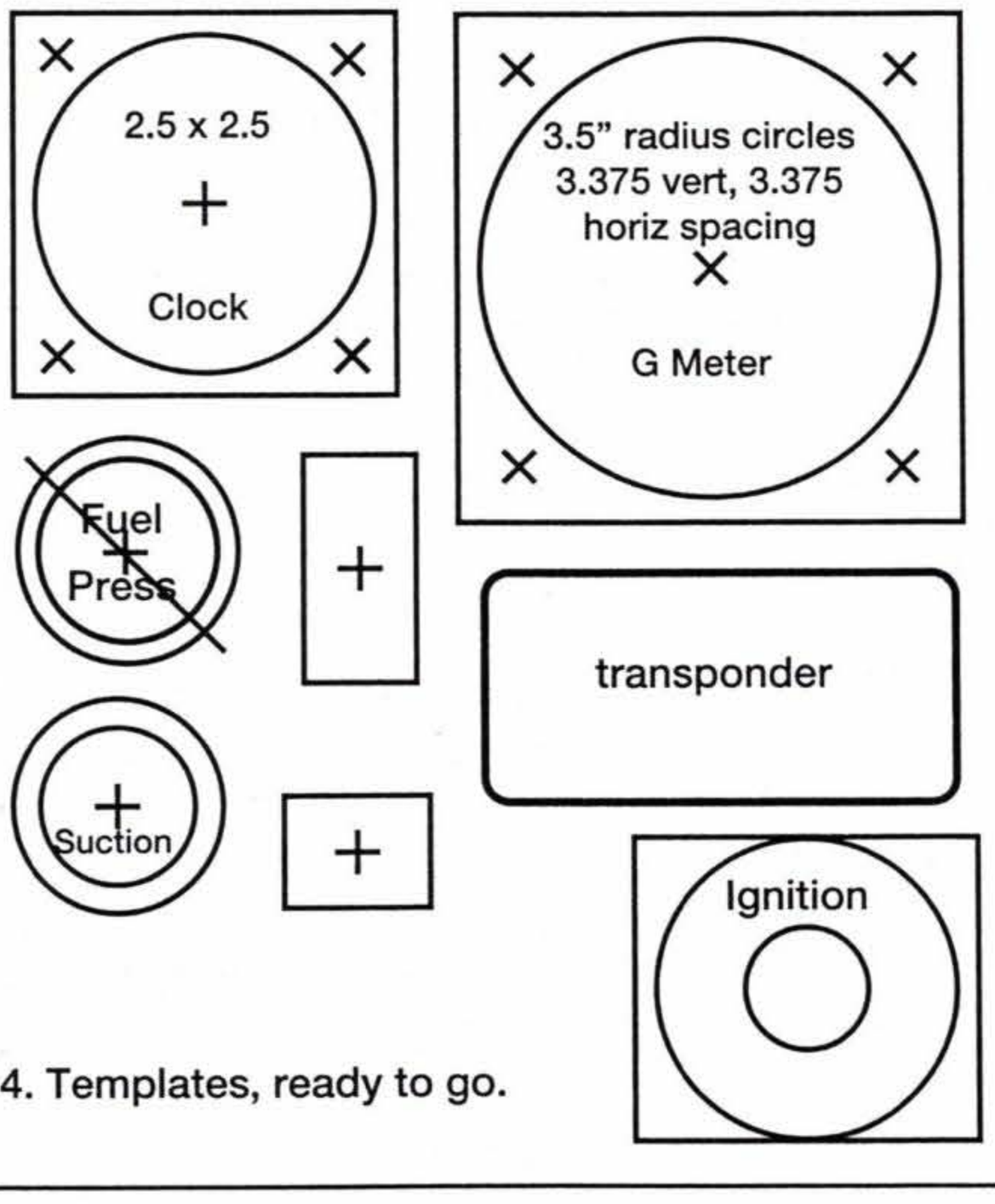


Figure 4. Templates, ready to go.

somebody who can let you use theirs at work after hours. You can print out full-sized layouts on multiple 8-1/2" x 11" sheets, or print at reduced size to see the whole panel on one sheet.

There are a few tricks to printing out full sized sheets, however. LaserWriters, like most electrostatic printing technologies, have minor errors in the final drawing size, but this is easy to measure. Make a sample drawing with two lines 10" apart, print it, and measure how far apart the lines really are. The LaserWriter I used was off by 1/3%, and the smallest adjustment I could make was 1%. For my purposes, I could live with the error. Another trick is in aligning the pieces of your layout across page breaks. I found that some added 45 degree lines, drawn to go across the page breaks, made alignment of the sheets much easier when I printed out the full sized layout, or you can break the layout into smaller pieces, each of which fits entirely onto a single sheet, and print those individually.

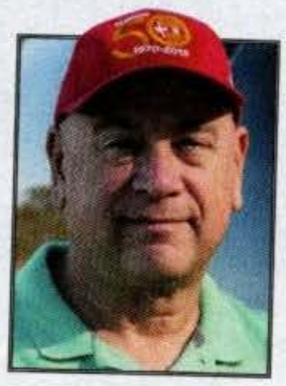
If you want a copy of my RV-4 panel layout and templates, mail me an initialized Macintosh disk, and enclose a return mailing label and stamps for return postage. I'm not on any electronic bulletin boards, but feel free to post the panel layout.

...ER ANTENNA INSTALLATION

Batteries and Alternators

The power of simplicity

BY VIC SYRACUSE



ONE NIGHT BACK WHEN I was building time for my commercial certificate, I decided to take a night flight in the Aero Club's C-172. I was stationed at Davis-Monthan Air Force Base, and night flights were a whole lot more comfortable in the heat of the Arizona summers. Unfortunately, the battery was too dead to start the engine. With the help of one of the instructors, we jump-started it. After startup, I tried contacting ground control multiple times for a taxi clearance and never got a response. Hmm, must be something blocking the antenna. I started to move the aircraft to get a direct line of sight to the tower. Immediately I noticed that the cockpit lights got much brighter when I increased the rpm. Pardon the pun, but another light bulb went off in my head. So, I increased the rpm and finally was able to communicate with the tower. Later, while doing touch-and-goes, I had to maintain higher-than-normal power settings on final and rollout to hear the tower controller's instructions. I also realized that this airplane had a generator, not an alternator, and generators are not nearly as efficient at producing power, especially at low rpm. I decided I didn't like generators!

No doubt that experience had an impact on me in my early flying days, as I caught a couple of in-flight electrical system failures before they caused serious trouble. It also caused me to focus on building robust electrical systems in the 11 aircraft I've built. It has paid off — I have never had an electrical failure of any kind in them and only had to jump the battery a couple of times due to having left the master switch on.

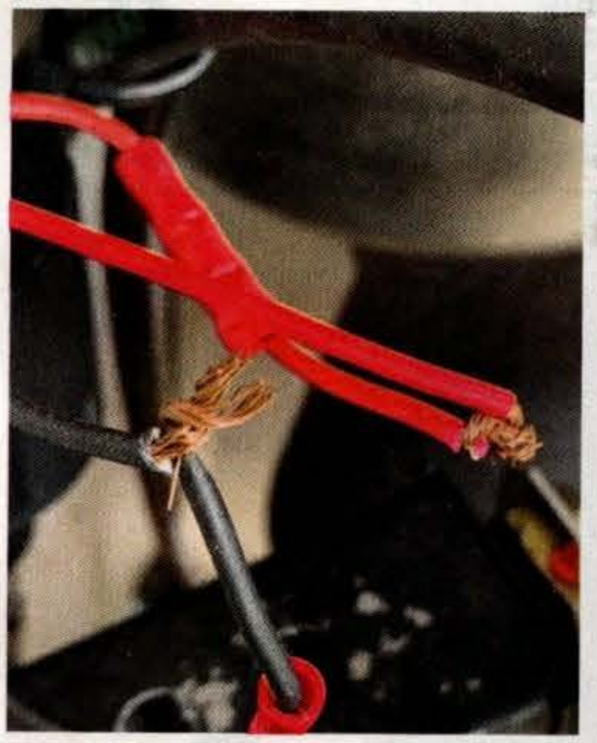
However, I can't say the same robustness is there in many of the electrical systems I see in the amateur-built aircraft world. It's really no surprise because the majority of the kits leave the electrical system details up to the builder. Quite honestly, even the certified airplanes I've worked on over the years have some convoluted electrical systems in them due to all of the changes over their 50 years of life by A&P mechanics who clearly didn't understand electrical systems either.

I am a firm believer in simplicity when it comes to electrical systems in airplanes. I know that will go against the thinking of those who feel a need to have multiple batteries and multiple buses with diodes separating them. Perhaps there was a time for each of those in the past, when for some reason all of the engine instruments were usually installed on the far side of the cockpit out of the normal vision of the pilot. That kind of instrument layout would cause the best of pilots to miss that the ammeter had gone from a slight positive charge to a negative charge, with recognition coming as the radios slowly got quiet as the battery no longer had enough energy left in it to allow the radios to receive, let alone transmit. With today's glass cockpits, and all of the available warning annunciators, I think there is a need for redundancy in only a couple of areas, and that is based upon experience.

Alternator belt tension

It is important to have the alternator belt properly tensioned. Otherwise, it will slip, especially under high electrical loads. Due to the loud cockpit environment, you won't hear the belt squeal that you can hear in your car when the belt is slipping. The cracked belt on the left should be replaced soon.

PHOTOGRAPHY COURTESY OF **VIC SYRACUSE**



Poor crimps (top), **frayed connection** (middle), **low-reliability wiring** (bottom)
Even the best alternators and batteries cannot overcome poor connections and low-reliability wiring. It is important to use the proper tool, especially on the large wires, or the crimps will work loose over time. High current wires with improper crimps will loosen and arc over time, causing corrosion and a path of high resistance.

I think the majority of builders out there have had the same experience with a dead battery that I did, and now, with all of the electronic gizmos in the cockpit, there is a real fear of the battery going dead at the worst possible time. I understand that line of thinking, especially for those of us in my age bracket. We still remember our childhood days and how all of the flashlights' batteries or bulbs were dead every time we went to use them. If they did light up, it seemed as though they had about 2 candlepower of lumens! Does anyone remember flashlight tag? Most everyone carried jumper cables in their cars, too.

My how things have changed. Now, we carry a flashlight in our pocket that uses a single AAA battery instead of two D cells. Some even seem bright enough to light up the moon on a dark night! Yep, battery technology and reliability have improved drastically during the last generation, and these improvements have found their way into aircraft as well. Most of the batteries installed in our airplanes today are no longer the messy lead-acid batteries of yesteryear but are absorbent glass mat or even lithium, both of which are maintenance-free and can provide many years of trouble-free service. Some can sit for up to a year and still start the engine without a jump-start.

So, that begs the question: Why should I carry two of them if they are so reliable? In a vehicle where weight is everything, carrying two 20-pound batteries is really detrimental. (In the case of dual electronic ignition that may require a power source, the second battery can be substantially smaller of course.)

But, if you decide to install two batteries, have you made certain they are installed in such a way as to properly charge? Are the aircraft switches clearly labeled as to how to use them? In one example in an aircraft with two batteries and two master solenoids, they used the second full-sized battery to help with hot starts through the use of two master switches. Once that second master switch was deactivated, the second battery was disconnected from the aircraft's charging system and, over time, it slowly died due to incomplete charges.

The reality is that a battery rarely fails anymore, especially if it is properly taken care of, meaning it is properly connected to the charging source in the aircraft and is not mistreated by being constantly left on a nonapproved battery tender/charger between flights. If your battery seems to be weak after a couple of weeks of not flying, I would bet you have something in your aircraft that is wired to the hot side of the battery and is slowly draining it. I have seen it multiple times, with the repeat offender being the 406 ELTs that require a 12-volt connection.

Switch jungle
This one probably speaks for itself. Yes, this was discovered on a flying airplane during a prebuy inspection!

Alternators these days are also reliable, much more so than the generators of yesteryear. So, why not lose that second battery and use that extra available weight for a second backup alternator? You'll still have weight savings, and the second alternator won't limit your flight time should the main alternator fail. I've had one on many of my airplanes and installed them on many customer airplanes. I have needed it only once, due to a regulator failure, and it got me through eight hours of flying with five stops. For IFR flying, I think it is one of the best investments you can make to increase the electrical system reliability. As an added plus, if your main alternator ever fails at some out-of-the-way airport on a Sunday evening or similar scenario, the backup alternator will get you all the way back home where you can address the problem on your time. Modern backup alternators are capable of 30-40 amps, which is a comfortable buffer for even the best-outfitted glass panels. During the installation, the backup alternator can be wired so that it comes online automatically in case of a main alternator failure, with a warning light informing you it has been activated.

PHOTOGRAPHY COURTESY OF **VIC SYRACUSE**

Proper charging voltage
If you aren't seeing 14 or more volts while in flight, you should carefully check over your charging system.

Backup alternator
Backup alternators make use of the vacuum pump drive and are capable of 20–30 amps, which is more than adequate to power even the best-equipped glass cockpits.

Another area that causes problems is not understanding how critical it is to properly size the wires. The largest wire in the system will be from the main battery all the way through the solenoids to the starter. This is usually a "0" or "00" gauge wire. It is super important that the ground wire from the battery to the airframe and from the airframe to the engine is of the same size. I see way too many installations where the ground wire is the same size as the alternator wire, which is horribly wrong. A starter can draw 200-300 amps when energized, hence the need for a very large wire. Most alternators are 40-60 amps, which only require a 6 or 8 AWG wire, which is substantially different than 00. Since a 6 or 8 AWG can't carry 200-300 amps, guess where all of the rest of the current flows? It goes through every other metal or wire connection to the engine, such as engine control cables, shields on shielded wires, etc. Undersized grounds make for slow-turning starters, which everybody initially thinks is a battery problem. Don't get fooled.

I also believe it is important to use high-quality aircraft alternators, good Tefzel aircraft wires, and the proper crimping tools for the connections for increased reliability.

In a nutshell, consider losing the second battery, add a backup alternator, and check those grounds. It will keep the fun factor alive. I assure you it is no fun to come back to the airplane with the family on the last day of that vacation trip and hear dead silence when the key is turned. EAA

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