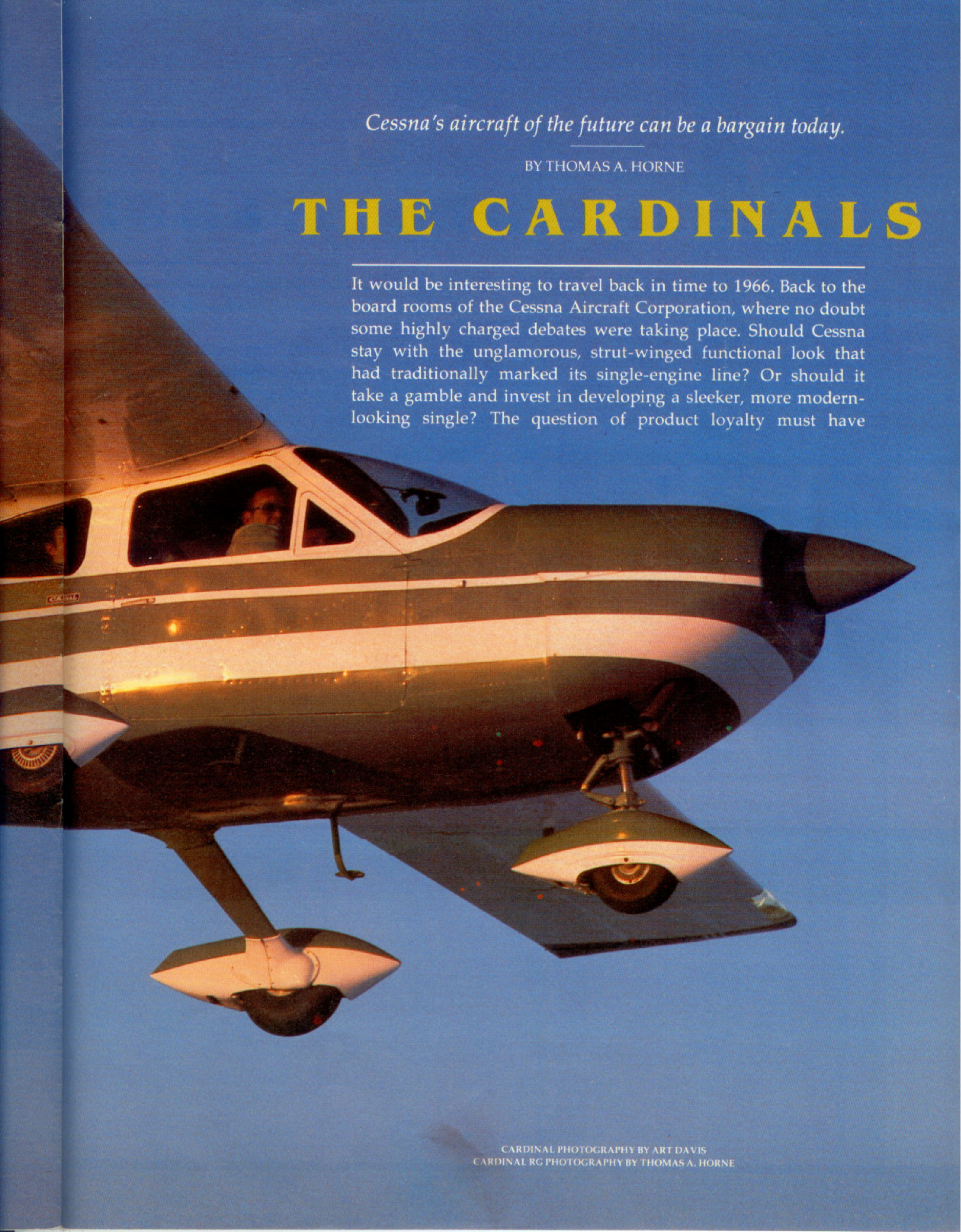

Cessna's aircraft of the future can be a bargain today.

BY THOMAS A. HORNE

THE CARDINALS

It would be interesting to travel back in time to 1966. Back to the board rooms of the Cessna Aircraft Corporation, where no doubt some highly charged debates were taking place. Should Cessna stay with the unglamorous, strut-winged functional look that had traditionally marked its single-engine line? Or should it take a gamble and invest in developing a sleeker, more modern-looking single? The question of product loyalty must have

CARDINAL PHOTOGRAPHY BY ART DAVIS
CARDINAL RG PHOTOGRAPHY BY THOMAS A. HORNE

come up. A pilot who learned to fly in a 150 could be counted on to buy a 172 or a 182 when decision time rolled around. Would this type of a purchaser also respond favorably to a radical design departure?

This was serious business. Early sales figures for 1967 Skyhawks indicated that they would not be moving as fast as they had the year before. The competition was worrisome. Piper's Cherokee 150s and 160s were selling well; they were a few knots faster than the Skyhawks and had base prices $1,000 to $2,000 less than the Skyhawk's $12,750. Beech's Musketeer had a base price identical to the Skyhawk's but a larger, more comfortable cabin and its sales were holding their own.

Out of this corporate quandary was born the Cessna 177, better known as the Cardinal. The idea—for the first two production years, anyway—was to produce both the Skyhawk and the Cardinal and see which way buyers leaned. It was an expensive decision. The Cardinal and its retractable-gear derivative, the Cardinal RG, have more refined features than the rest of Cessna's singles. Some features were adapted from Cessna's top-of-the-line single, the 210 Centurion, which had been in production since 1959.

For example, the Cardinal has cantilevered (strutless) wings, just like the 210. Extra-heavy wing spars make this possible. Instead of the Skyhawk's simple, piano-hinged ailerons, the Cardinal's move on a set of bearings, also borrowed from the 210. Likewise, the fuel vents are located at the wing's trailing edge, eliminating the chance of any icing problems in that area.

There were other innovations that made the Cardinal stand out. The wing is a NACA 6400-series laminar-flow airfoil, with flush riveting halfway down its chord. The wide-span, "para-lift" flaps have a variable chord, narrower at the outboard portions and thicker at the wing roots. The flaps also have a semi-Fowler action, meaning that they extend aft slightly when lowered, giving more lift at slower airspeeds. The Cardinal's main landing gear is one conically tapered piece with machined, tubular structures and with molded rubber bushings at the outboard attach points. Cessna called the new gear arrangement "cushion-ride" because of the gear's ability to flex in all directions and dampen side loads. The gear was much more complex than the rigid, spring-steel Land-O-Matic gear used on the Skyhawks.

The Cardinals were also the first Cessna airplanes to use a stabilator instead of a conventional elevator. This, and the modified Frise aileron design, gives the Cardinal rather quick control responses. Only very light control pressures are needed to effect a change in the airplane's attitude.

These engineering efforts were a nice touch, but Cessna was selling more

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than a package of new technology. The car/airplane analogy was seized upon by Cessna's marketing staff. The early brochures featured a Day-Glow print job and showed an amorous young couple lounging around the Cardinal, a Corvette Sting Ray in the background. Speaking of prospective owners, the brochures said that "they're a new flying generation. . .Cardinal people, and the Cardinal has flown right out of the future to meet them more than halfway." Other passages proclaimed the "fastback revolution" and called the Cardinal "the airplane of the seventies." The message was youth, energy, speed and style.

The styling was designed to impress pilots and passengers alike. A Cardinal sits low to the ground (23 inches). Its large windshield slants back at a rakish 45-degree angle to meet a wing that has its leading edge set back to a point just above the pilot's head. From the front seats, the wings give the impression of being extensions of the pilot's shoulders. Visibility is very good for a high-wing design.

A pair of huge, four-foot wide doors open a full 90 degrees to allow an unencumbered entry to the cabin. The absence of struts makes climbing in and out easier, too. The cabin itself is unusually large for any single, let alone a Cessna. The front seats are vertically adjustable and even recline. Front- and rear-seat occupants have plenty of legroom, and the width of the cabin (3 feet by 8 inches) means that no one will have that packed-in feeling. Headroom is a bit diminished, though, because of the size of the wing spars.

On the whole, the Cardinal's interior is vastly preferable to that of the Skyhawk's; on a scale from one to 10, I give the Cardinal's a nine, and the Skyhawk's a two. And what is that at the front of the door? A crank-operated vent window, just like the ones automobiles used to have. I tell you, they thought of everything in the creature-comforts of this airplane. Why, if you bought a Cardinal ($1,500 extra) instead of the standard 177, you even had rear-seat armrests and ashtrays, a carpeted baggage area, scuff panels, seat-back map pockets, a clock, outside

air temperature gauge, a set of vacuum-driven gyro instruments, speed fairings and white sidewall tires. It was an airplane calculated to take some of the disbelief out of the stares of your relatives as you taxied up for your Christmas visit. Most pilots agree that the 177 series is the best-looking and most comfortable of all the singles that Cessna ever produced.

But you have to take the bad with the good, and the 177/Cardinal and Cardinal RG, as with any airplane, have their drawbacks. We can look at the changes Cessna made over the years to see how some of their shortcomings were dealt with.

The first 177s and Cardinals came with 150-hp Lycoming O-320-E engines and fixed-pitch propellers. Though the handbook claimed a 670-fpm climb rate on a standard day—consistent with the performance of any 150-hp single-engine airplane—the 1968 Cardinal acquired a reputation as a slow airplane that was reluctant to climb as well as promised. Perhaps owners and pilots were disappointed that such an aerodynamically clean airplane would not climb or cruise faster. But because of the model's 150-hp and a gross weight of 2,350 pounds, you can expect only so much.

The controversy surrounding the 1968 Cardinal's allegedly poor performance was fueled by an investigation that followed a crash in 1972. A Cardinal with four people aboard took off from a field with a density altitude of 5,000 feet and shortly thereafter crashed. The pilot's survivors hired a test pilot to take another look at the Cardinal's book figures. Using test methods no more scientific, definitive or reliable than those used by Cessna, this investigation concluded that the 150-hp Cardinal's sea-level, standard-day rate of climb was really 560 fpm.

The Skyhawks of the day, even though they had only 145 hp, could outperform the Cardinal because of their lower empty weights, higher useful loads and lighter fuel loads. They were as fast and cost about $1,500 less.

Comparing the Cardinal to the Skyhawk brings to mind some complaints registered by fixed-base operators and Cessna dealers who were unfamiliar with this new airplane's handling qualities. For an airplane that was meant to replace the Skyhawk, it had some very different characteristics. Takeoffs and landings were the biggest concerns.

Picture the scene: Along came a prospective customer or a pilot wanting a check-out in this sharp-looking new airplane. He might have been familiar with the Skyhawk's behavior near the ground, but the slippery Cardinal with its fancy new stabilator had some surprises in store for him. The sensitivity of the controls often meant that the neophyte Cardinal pilot would leap suddenly into the air on takeoff. Using 10 degrees of flaps for takeoff (the flap switch has preselect positions and a flap position indicator to aid in setting flaps) can make for an easier transition to flight; the flight manual recommends this technique.

On final, the tendency was to come in hot, the pilot unaware that it can be easy for a Cardinal to pick up airspeed, if neglected, and difficult to bleed off that extra speed without consuming a lot of runway. The lightness of the stabilator forces often meant that the pilot

would overcontrol, sending the Cardinal porpoising down the runway. Under certain high-angle-of-attack situations, the stabilator of the 1968 177/Cardinal could stall before the wings. This guarantees a sudden pitchdown.

In April of 1968 a fat service letter, SE68-14, arrived at Cessna dealers. The service letter detailed Operation "Cardinal Rule"—a series of 23 inspection, installation and modification instructions to be carried out immediately on all 177s and Cardinals. Among the 23 was a modification requiring slots just behind the leading edges of the stabilator. The air flowing through the slots and over the top of the stabilator delays the onset of a stabilator stall.

The 1969 model year brought with it the 177A and Cardinal and a predictable increase in horsepower. The 150-hp engine was replaced with a 180-hp Lycoming O-360-A. This provides a better published rate of climb (760 fpm), a 150-pound increase in gross weight and a four-knot increase in cruise speed. Loading still has to be managed carefully with these models because with full fuel, the unequipped 177 can carry only 841 pounds and the Cardinal 766. As with the 1968 models or, for that matter, any other single or light twin, partial fueling is necessary more often that not when four passengers plus baggage are on board. A series of holes in the fuel tank filler necks indicates when 21.5 gallons are in each tank; filling to these marks gives you an additional 36 pounds in useful load.

There was another change made to the stabilator, too, besides the slots. The control linkage was changed. The ratio between control-wheel movement and stabilator travel was reduced, presumably to reduce the tendency to overcontrol in the flare. In the same vein, a beefed-up tiedown ring (now called a combination tiedown ring and tail skid) was installed, along with an upswept, reinforced tailcone. Those in the know say that one quick way to tell a 1968 from a 1969 is to look carefully at the tail. If the slots have that field-installed, Bond-o look, if the tiedown

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ring shows scrape marks and if the tailcone is wrinkled, it is a 1968.

The bad reputation established by the underpowered 1968 Cardinal plagued each of the succeeding models, in spite of the consistent pattern of yearly improvements. After an initial burst of success, sales never revived. The drop in sales was so profound (1,158 in 1968, 255 in 1969) that one wonders why Cessna built them for 10 years. Meanwhile, sales of the Skyhawk resumed their normal vigor, outselling the Cardinal by up to 10 to one.

The 177B came next, in the 1970 model year. This time, a constant-speed propeller and cowl flaps were added, along with a more docile, NACA 2400-series airfoil, which lowered stall speed by three knots. Performance went up; sales went down, this time to 160 airplanes.

We might just as well end the history of the fixed-gear Cardinals with the 177B, because no more new model designations were made. There were some minor changes. In 1971, Cessna put extra padding in the panel and door posts, offered inertial-reel shoulder harnesses as an option and rearranged the landing light in a newly designed nose cap. In 1972, 177s and Cardinals came with padded yokes, a bonded-metal cowling and polyurethane gear bushings, instead of the old rubber ones. In 1973, optional 60-gallon long-range fuel tanks were offered. In 1975, the "Buy n' Fly" program was instituted, a sure sign that Cessna was desperate to sell Cardinals. If you bought a 177/Cardinal, Cessna would foot the bill for your private pilot license. If you bought a Cardinal II with Nav-Pac (an ARC 300 Nav/Com, transponder and automatic direction finder), Cessna would pay for your instrument rating, too. That same year, the door hinges were strengthened, and cruise speed went up a few knots thanks to some changes in the engine's cooling baffles and cowl openings. The reason for the beefier door hinges is simple: The doors are so heavy and large, they can overstress their mounts. They also act as very efficient sails in windy conditions. More than one pilot has parked the Cardinal with its tail to the wind, then opened the door, only to have it yanked from his grip and thrown forward against the cowling.

The really big change to the 177 series was announced by Cessna in December 1970, and the news hardly was unexpected. Production of the Cardinal RG had begun.

With a 200-hp, fuel-injected Lycoming IO-360-A engine, the RG could cruise an easy 20 knots faster than the fixed-gear Cardinal and carry more. The question was whether those 20 knots were worth a $7,000 higher price tag and the maintenance costs that come with retractable gear. The Cardinal RG seemed to be treading on the Cessna 182 Skylane's territory. The Cardinal RG is capable of cruising 10 knots faster than a Skylane and can burn 40 percent less fuel doing it. The only advantages the Skylanes have are higher useful load, maintenance-free fixed gear and a slightly lower price. For most Cessna purchasers, this was enough to keep them from buying a Cardinal RG. The same mismarketing that caused the fixed-gear Cardinal to lose to the Skyhawk was being revisited on the Cardinal RG.

Against the retractable-gear competition, the Cardinal RG holds up very well. Of all the 200-hp retractables in the marketplace, only the Mooneys are faster. Owners report that a Cardinal RG will leave both the Piper Arrow and the Beechcraft Sierra far behind when flown at the same power setting.

The most significant changes in the Cardinal RG's genealogy came in 1972 with a larger propeller diameter, a different propeller airfoil and some drag elimination. The fixed cabin step was done away with, and the use of more bonded metal in the cowling brought increases in rate of climb, range and endurance and added a few more knots to the Cardinal's cruise speeds.

In 1973, optional 60-gallon fuel tanks were offered. This same year the fuel-selector design was changed. Prior to this, the fuel was drawn from both tanks simultaneously—there was no provision for using either the left or the right tank only. It was either Both or Off. This results in uneven fuel burns, creating trim and fueling problems. The newer fuel selectors have four positions: Left, Both, Right and Off. The fixed-gear Cardinals retained their firewall fuel shutoff valves, located just below the trim wheel.

In 1976, both the fixed- and retractable-gear Cardinals had their panels redesigned, allowing more space for avionics. The glareshield was extended across the entire length of the panel; before, it dipped down to the right of the panel's center.

In 1978, the end finally came for both the Cardinal and the Cardinal RG. That year, only 69 and 96 models, respectively, were built. The fixed-gear

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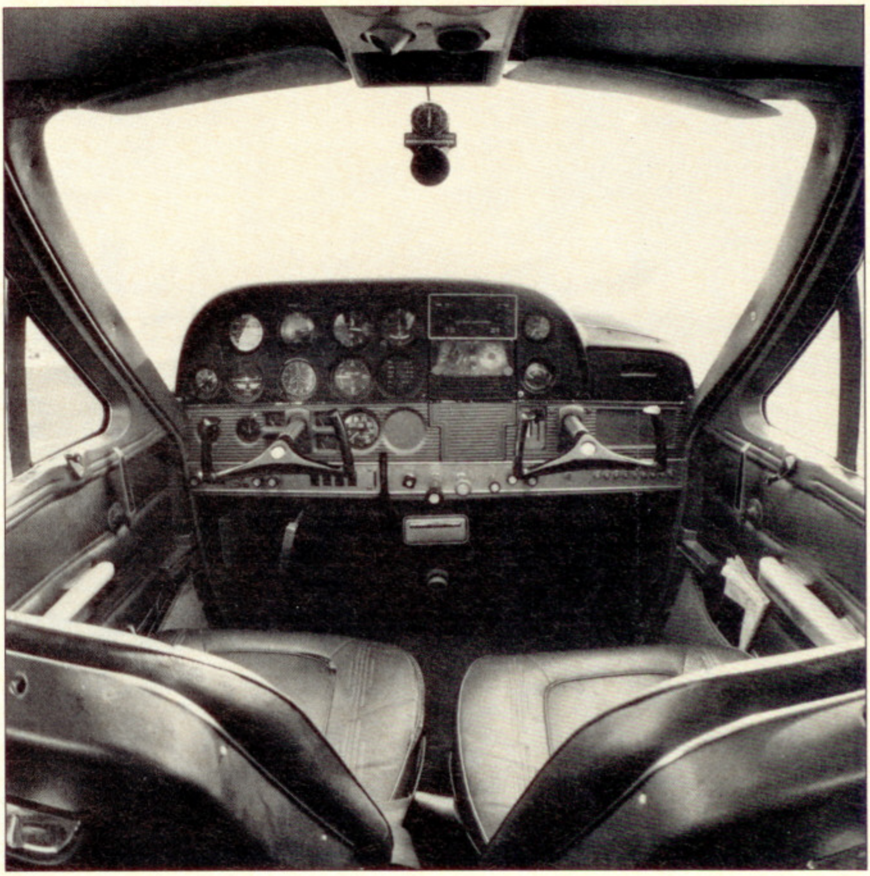

The Cardinal's cabin is wide and surrounded by glass. Beginning in 1976, the glareshield extended the length of the panel, permitting more space for avionics.

177B came out with a special-edition version of the Cardinal to mark the occasion—the Cardinal Classic. Cessna charged a whopping $50,000 for this beauty, which came with dual ARC 300 Nav/Coms and a glideslope receiver, transponder, ADF, autopilot, large leather seats with armrests, a simulated-wood-grain panel and a personalized, engraved nameplate as standard equipment. All Cardinals came with a 28-volt electrical system that year and an avionics master switch. For the RG, a more powerful hydraulic power pack was installed. This lowered its retraction time from 13 to six seconds.

Although the Cardinals were a loss for Cessna, they could be your gain if you are in the used-airplane market. Fixed-gear Cardinals can be bought for prices in the $9,000 to $29,000 range, depending on condition and equipment. It is the kind of airplane that inspires pride in most owners, so many are still in very good condition and can bring a better price than you might expect. The 1968s are the ones most often advertised, and in spite of their alleged shortcomings, many feel that this airplane is destined to become a classic. A recent issue of *Trade-A-Plane* listed eight for sale, with asking prices from $10,900 to $19,950.

The 1968 Cardinal photographed for this article belongs to David Dodds of Frederick, Maryland. Dodds, a lab specialist with the AOPA Air Safety Foundation's Flight and Technology Laboratory, bought his Cardinal at a bargain price, then set to work correcting the damage the airplane had suffered from sitting outside—unused—for five years. Four weeks later, he had a very nice airplane.

One plus for used Cardinals is that there were not many airworthiness directives issued against them. Service difficulty reports abound, for sure (especially for the RGs), and dealer servicing and parts availability are major problems; but there are no recurrent ADs in effect on any of the 177 series.

When shopping for a Cardinal, there are some specific trouble areas to investigate. One AD (79-10-14) issued in 1979 required that vented fuel caps and associated hardware be installed to replace the original caps. The old caps had a tendency to admit water past their seals, so many of the older Cardinals accumulated water in the fuel system. One owner reported that water had contaminated his entire fuel system. The damage caused by the water required a new fuel pump, gascolator and servo unit. This AD should have been complied with by now, but on a neglected airplane, watch for potential water problems.

Leaky door seals and windshields are also a frequent complaint of Cardinal owners. If the doors are not sealed properly, or do not fit well, the front-seat occupants can expect a shower when flying in rain. The doors can come out of rig easily due to flying in turbulence or stresses on the hinges.

Overhauled or remanufactured 180-hp Lycoming O-360-A1F6 engines used in some fixed-gear Cardinals were the subject of AD 75-8-9. Before these engines have accumulated 400 hours' service, their oil pumps must be replaced. Again, this should have been taken care of, but you never can tell unless you investigate the logbooks.

It also would be a good idea to put the fixed-gear Cardinal you intend to buy up on jacks to see if the gear legs are firmly set in their saddles. Bounced landings and side loads can loosen the gear, making them flex more than they ought to and cause internal damage.

Upkeep on a fixed-gear Cardinal is relatively low. An annual should cost an average of $500, and the low number of service difficulty reports filed against the straight 177s (compared to the Cardinal RG) testifies to the simplicity of their construction.

The Cardinal RG is another matter. Here, you should concern yourself with the landing gear's service history, since the gears' electrically actuated hydraulic power pack, its downlocks, solenoids, gear-warning horn and switches were all the subject of numerous owner complaints and Cessna service bulletins. Four different landing-gear systems were installed in the RG in the eight years it was in production.

Tales of landing gear that failed to extend or retract are rife. The nose gear seems especially prone to malfunction. False indications and faulty warning horns were also a common problem.

For a system designed to be simple, the Cardinal's gear problems seem infinitely complex. A variety of fixes were tried through the dealer network (with a succession of service bulletins). Some worked, some did not. The quality control at Cessna apparently condoned little uniformity in construction, so there is little uniformity in the effect of modifications.

So when looking at a used Cardinal RG, you will ask for the gear system's service records, right? This is also a good time to ask if the airplane has ever made a gear-up landing.

Beauty, then, brings with it a price. In the fixed-gear Cardinals, it can be performance and loading problems. In the RG, it is maintenance as well as loading, with a hump-shaped baggage compartment thrown in for good measure (the main-gear wheel wells are underneath).

But they are stable airplanes that behave well in turbulence and IFR conditions. They are economical, too. For the eight to 10 gph that a Cardinal will burn, you get anywhere from 120 to 140 knots true airspeed, excluding the 150-hp models. And their range and endurance profiles are excellent with partial payloads and full fuel.

It is sad to see any airplane go out of production, but with the Cardinals, their fate seems particularly ironic. Just as it had corrected most of the Cardinals' deficiencies, Cessna stopped making them. The fixed-gear Cardinal was replaced by the Hawk XP, which has a host of maintenance problems, burns more fuel and looks as plain as a Skyhawk. The Cardinal RG was replaced by the 182 Skylane RG, which can carry more and fly faster, but only because of its 235-hp engine. It is interesting to note that the gear system used on the 182 RG is the same one used in the late-model Cardinal RGs. This system has far fewer reported difficulties.

For a used-airplane shopper, the Cardinals can make a lot of sense. They offer the looks and speed you will not find in any other used Cessna single with 200 horsepower or less, and, once purchased, they will hold their value fairly well, despite their reputation. Just make sure the guy you buy it from thinks it is a lemon. That way, you will pay less and everyone will be happy. The owner got rid of his Cardinal, and you got a good deal. After flying it for a while, you might even enjoy that, too. And, like so many others, you will wonder what all the fuss was about and why Cessna turned its back on the only stylish single it has ever made. □

Specifications and "Gear Shift" overleaf

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	Model 177	Model 177A	Model 177B	Model 177B	Model 177RG
	1968	1969	1970 – 1972	1973 – 1978	1971 – 1978
Price new	$12,995 to $14,500	$15,775 to $16,995	$16,795 to $19,300	$19,300 to $32,600	$24,795 to $43,950
Current market value	$9,000 to $14,000	$10,000 to $15,000	$12,000 to $20,000	$14,000 to $28,000	$17,000 to $29,000
Specifications					
Powerplant	Lycoming O-320-E2D 150 hp @ 2,700 rpm	Lycoming O-360-A2F 180 hp @ 2,700 rpm	Lycoming O-360-A1F6 180 hp @ 2,700 rpm	Lycoming O-360-A1F6D 180 hp @ 2,700 rpm	Lycoming IO-360-A1B6D 200 hp @ 2,700 rpm
Recommended TBO	2,000 hr	2,000 hr	2,000 hr	2,000 hr	1,400 hr to 1,800 hr
Propeller	McCauley, fixed pitch, 2 blade, 76 in	McCauley, fixed pitch, 2 blade, 76 in	McCauley, constant speed, 2 blade, 76 in	McCauley, constant speed, 2 blade, 76 in	McCauley, constant speed, 2 blade, 78 in
Wingspan	35 ft 7.5 in	35 ft 7.5 in	35 ft 6 in	35 ft 6 in	35 ft 6 in
Length	26 ft 11.5 in	26 ft 11.5 in	26 ft 11.5 in	27 ft 3 in	27 ft 3 in
Height	9 ft 1 in	9 ft 1 in	9 ft 1 in	8 ft 7 in	8 ft 7 in
Wing area	172.8 sq ft	172.4 sq ft	173.6 sq ft	173.6 sq ft	173.9 sq ft
Wing loading	13.6 lb/sq ft	14.5 lb/sq ft	14.4 lb/sq ft	14.4 lb/sq ft	16.1 lb/sq ft
Power loading	15.7 lb/hp	13.9 lb/hp	13.9 lb/hp	13.9 lb/hp	14 lb/hp
Seats	4	4	4	4	4
Cabin length	10 ft 1.5 in	10 ft 1.5 in	10 ft 1.5 in	10 ft 1.5 in (10 ft 11.5 in – 1975 on w/opt hatrack)	11 ft 2.5 in (11 ft 9.5 in – 1975 on w/opt hatrack)
Cabin width	3 ft 8 in	3 ft 8 in	3 ft 8 in	3 ft 8 in	3 ft 8 in
Cabin height	3 ft 6 in	3 ft 6 in	3 ft 6 in	3 ft 6 in	3 ft 9 in
Empty weight	1,415 lb	1,440 lb	1,475 lb	1,495 lb	1,765 lb
Useful load	935 lb	1,060 lb	1,025 lb	1,005 lb	1,035 lb
Payload w/full fuel	647 lb	772 lb	731 lb	711 lb	675 lb
w/opt tanks	N/A	N/A	N/A	645 lb	N/A
Gross weight	2,350 lb	2,500 lb	2,500 lb	2,500 lb	2,800 lb
Fuel capacity (usable)	288 lb/48 gal	288 lb/48 gal	294 lb/49 gal	294 lb/49 gal	360 lb/60 gal
w/opt tanks	N/A	N/A	N/A	360 lb/60 gal	N/A
Oil capacity	8 qt	8 qt	8 qt	9 qt	9 qt
Baggage capacity	120 lb	120 lb	120 lb	120 lb	120 lb
Performance					
Takeoff distance (ground roll)	845 ft	845 ft	750 ft	750 ft	890 ft
Takeoff over-50 ft obst	1,135 ft	1,575 ft	1,400 ft	1,400 ft	1,585 ft
Rate of climb, sea level	670 fpm	760 fpm	840 fpm	840 fpm	925 fpm
Max level speed	125 kt	130 kt	133 kt	135 kt	156 kt
Cruise speed/Range* (Range w/opt fuel) Fuel consumption @75% power					
5,000 ft	114 kt/645 nm (N/A) 49.8 pph/8.3 gph	115 kt/550 nm (N/A) 60.6 pph/10.1 gph	121 kt/540 nm (N/A) 60.6 pph/10.1 gph	122 kt/558 nm (725 nm) 60.6 pph/10.1 gph	144 kt/715 nm (N/A) 64.2 pph/10.7 gph
7,500 ft •	115 kt/665 nm (N/A) 49.8 pph/8.3 gph	118 kt/560 nm (N/A) 58.8 pph/9.8 gph	123 kt/600 nm (N/A) 60.6 pph/10.1 gph	124 kt/605 nm (740 nm) 60.6 pph/10.1 gph	146 kt/740 nm (N/A) 62.4 pph/10.4 gph
@55% power					
5,000 ft	96 kt/730 nm (N/A) 37.8 pph/6.3 gph	100 kt/650 nm (N/A) 44.4 pph/7.4 gph	102 kt/680 nm (N/A) 44.4 pph/7.4 gph	103 kt/680 nm (830 nm) 44.4 pph/7.4 gph	127 kt/830 nm (N/A) 49.8 pph/8.3 gph
7,500 ft	97 kt/740 nm (N/A) 37.2 pph/6.2 gph	101 kt/655 nm (N/A) 44.4 pph/7.4 gph	104 kt/680 nm (N/A) 45 pph/7.5 gph	104 kt/680 nm (835 nm) 44.4 pph/7.4 pph	132 kt/840 nm (N/A) 49.2 pph/8.2 gph
10,000 ft	98 kt/750 nm (N/A) 36.6 pph/6.1 gph	103 kt/670 nm (N/A) 43.8 pph/7.3 gph	102 kt/690 nm (N/A) 43.8 pph/7.3 gph	102 kt/690 nm (840 nm) 43.8 pph/7.3 gph	133 kt/850 nm (N/A) 48 pph/8 gph
Service ceiling	12,700 ft	15,800 ft	14,600 ft	14,600 ft	17,100 ft
Landing over 50-ft obst	1,575 ft	1,220 ft	1,220 ft	1,220 ft	1,350 ft
Landing distance (ground roll)	400 ft	435 ft	600 ft	600 ft	730 ft
Limiting and Recommended Airspeeds					
Vx (Best angle of climb)	62 KIAS	66 KIAS	67 KIAS	67 KIAS	67 KIAS
Vy (Best rate of climb)	76 KIAS	77 KIAS	80 KIAS	80 KIAS	82 KIAS
Va (Design maneuvering)	98 KIAS	102 KIAS	102 KIAS	102 KIAS	113 KIAS
Vfe (Max flap extended)	91 KIAS	91 KIAS	91 KIAS	91 KIAS	95 KIAS
Vle (Max gear extended)	N/A	N/A	N/A	N/A	125 KIAS
Vno (Max structural cruising)	126 KIAS	130 KIAS	134 KIAS	134 KIAS	142 KIAS
Vne (Never exceed)	161 KIAS	161 KIAS	161 KIAS	161 KIAS	174 KIAS
Vs1 (Stall clean)	56 KIAS	57 KIAS	55 KIAS	55 KIAS	57 KIAS
Vso (Stall in landing configuration)	46 KIAS	49 KIAS	46 KIAS	46 KIAS	50 KIAS

All specifications are based on manufacturer's calculations. All performance figures are based on standard day, standard atmosphere, at sea level and gross weight unless otherwise noted. N/A, not applicable.

** Range specifications for 177 models are calculated with no reserve. Range specifications for 177RG model include a 45-minute reserve at 45-percent power.*

GEAR SHIFT

Cessna's RG learning curve

Problems with the Cardinal RG's landing-gear system are alluded to in the accompanying article; but it is worth taking a closer look at the system's designs and Cessna's service recommendations to understand these problems more completely.

Four different systems were used in the Cardinal RG during its production, and Cessna distributed eight service bulletins intended to correct various deficiencies.

The first system was installed on all 1971 and 1972 Cardinal RGs. This landing gear system has caused the most difficulties because of its use of electrically actuated downlocks for the main gear. The quality and reliability of this system's many microswitches and reed switches also have been criticized.

The first system works like this: Let us say, you select gear down. Moving the selector handle to the Down position, you send an electrical signal (via mechanical linkages) to a remotely mounted selector control unit in the nosewheel tunnel. This in turn sends an electrical down command to the 12-volt Prestolite hydraulic power pack located in the tailcone. The pump then sends hydraulic pressure directly to the actuators. The gear actuators—one for the nose and one for the mains—send the landing gear on its way down.

When the main gear reaches its furthest limit of travel, a pair of electrical switches senses that the gear is ready to be locked. These switches are fitted with magnets; when the metal in the gear assembly reaches the proper position, the magnets pull the downlock switches into contact. Because these switches do not need to touch the gear physically to do their job, they are termed proximity switches.

The downlock switches thus activate a pair of solenoids, which drive the locking pins into place. Then another set of proximity switches senses that the locking pins are engaged. This closes yet another circuit, this one connected to the green Gear Down light on the instrument panel.

The nose gear locks down by means of a mechanical linkage incorporating the over-center principle. (This is what makes a light switch work; it is either on or off. A cam prevents the light switch from hanging up in between on and off, and the same principle applies to landing gear.) The nose gear also has a gear-down indicator circuit to the panel, plus a gear-up indicator circuit and a squat switch. In all Cardinal RGs, there is only one gear-up indicator switch and one squat switch—both located in the nose-gear assembly.

System two is installed in 1973 Cardinal RGs. The big change here is the use of hydraulic downlock actuators instead of the first landing gear system's electrically driven locking arrangement. This proved to be a more reliable design because of its simplicity. The same hydraulic force that drives the gear actuators also drives the downlock actuators, which, incidentally, were the same ones then used in the Cessna 210 gear system.

System three (1974 through 1977 model years) brought with it two more important improvements. The selector handle was redesigned and made into a hydraulic valve in order to cut down on the system's wiring. The direct routing of hydraulic pressure to the actuators was discarded in favor of sending it first through a panel-mounted valve controlled by the selector handle. The remote electrical control unit also was eliminated with system three.

Now, the function of the electrical circuitry is limited to only three functions: to run the power pack's electrical motor, to power the indicator lights and to operate the squat switch.

The last system change affects only the 1978 models. The main difference between this system and the one preceding it is the power pack. Cessna dropped the 12-volt Prestolite units and went with a 24-volt power pack of its own design. It incorporates a thermal relief valve, which shuts the electrical motor off if overheating occurs, and a new, externally vented auxiliary hydraulic fluid reservoir. The fourth system is the most reliable of all and has caused very few maintenance problems.

Half the service letters affecting the Cardinal RGs' landing gear did not require

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mandatory compliance. But they reflect difficulties experienced by owners and operators of the airplane and are revealing in that they disclose some of the systems' more serious weaknesses. Here they are, in chronological order:

• **71-41** This service letter applied to all 1971 Cardinal RGs and ordered changing the recessed bulkhead fittings connecting the power pack to the hydraulic lines to fittings that protruded through the bulkhead. This makes removal and installation of the hydraulic lines much less tedious and exacting.

Also included in this letter were instructions to install an improved emergency hand-pump check valve. The purpose of this new check valve was "to provide positive opening and closing of the valve." The original check valve could allow an equalization of up and down hydraulic force on either side of the valve. Such an equalization commonly is called a hydraulic lockout. If a lockout were to occur, the emergency pump handle would be rendered ineffective since pressure would not be available to pump the gear down. In fact, the handle would be immobilized in a lockout situation.

Because of the obvious safety implications, this letter required compliance.

• **72-26** This was another service letter with mandatory improvements. Installation of heavy-duty downlock solenoids on the first system was required. These solenoids exerted more force than the original ones, providing a more positive engagement and disengagement of the main gears' downlock hooks. They also allowed wider variation in rigging tolerances.

Bonding of the downlock attach bolts also was mentioned. The idea was "to improve downlock retention and stabilize the solenoid attach brackets." What this really meant was that the solenoids, switches and downlocks could flex with the existing structure, thus preventing a positive downlock or throwing the switches out of tolerance, or both. With the switches out of tolerance, the pilot could receive false gear-up or gear-down indications.

The bulletin also required adding a silencer pad to the main landing-gear supports "to provide better support for the gear and to keep them parallel. . . ." Apparently, the main gears' legs were not contacting their supports evenly as they cycled up and down. This sometimes caused wear in the pivot points, which could contribute to excessive play as the main gear was operated.

The fourth improvement had to do with the main-gear down indicator switches. New switch mountings were designed, and a striker plate could be added "to improve switch operation reliability."

• **73-28** This was billed as a "nosewheel-retraction and indicator-switch improvement," suggesting a check of the steering-collar bolt's tightness to ensure that the nosewheel centered as it retracted. Some airplanes' bolts were too tight, causing the nose gear to remain cocked to one side after takeoff.

Reports from the field indicated that the squat-switch plunger on many models would not make contact after takeoff, preventing gear retraction. There was a reminder to clean and lubricate the squat switch and a list of instructions on how to test the gear indicator switches.

A revised nose-gear switch rigging was authorized to ensure a more positive down-lock indication. This involved merely shimming the switch so that contact between the downlock and switch was guaranteed.

The procedures outlined in this letter were mandatory.

• **74-26** This service letter affected all 1972 and 1973 Cessna singles. It recommended replacing aluminum-flanged nosewheels with steel assemblies, presumably for greater strength.

• **75-25** This was a reminder to mechanics to be sure to check the Cardinal RG's nose-gear actuator rod end for security, leaks and damage, preferably at 100-hour intervals. Apparently, this part was too fragile to hold up under rough use, and Cessna felt it bore watching.

• **76-4** This bulletin involved the option to replace the nose gear's indicator switches (one switch to light the amber Up light and one for the green Down light) with a single switch that performed both functions. Beginning with the 1976 RGs, the single switch was made standard equipment.

Another electrical simplification addressed in this bulletin had to do with the switches on the power pack's electrical motor. Except for the electrical motors in system four, Cardinal RGs have two switches that maintain hydraulic pressure at the proper level. One switch senses hydraulic pressure. The other is a shutoff relay. For the power pack to function adequately, hydraulic pressure must be between 1,100 pounds per square inch (1,000 psi in system four) and 1,500 psi. In the older systems, the pressure switch signals the relay switch to turn on the electric motor if hydraulic pressure dropped below 1,100 psi or to turn it off if too much pressure built up in the system.

The modification in this bulletin recommends substituting the two-switch system with a single switch that performs the functions of both pressure sensor and shutoff switch. This was a response to complaints of motors failing to shut off when they were supposed to. Because of faulty relay switches, some Cardinal RG electrical motors ran on and on until they burned out. Installation of the simpler, one-switch system helped reduce the possibility of a runaway motor.

• **76-7** This applied to 1975 and 1976 RGs and was a mandatory operation. The original nose-gear actuator rod ends (the subject of bulletin 75-25) had to be replaced with new, stronger ones.

• **77-20** This recommended an inspection and cleaning of the power pack's pressure switch. Every 1,000 hours an overhaul and relubrication of the switch was suggested.

Talks with mechanics about the Cardinal's gear system will identify some of the common problems encountered in routine maintenance of the aircraft.

"Tinker-toy microswitches is what I would call them," said T.S. Alphin of Alphin Aircraft in Hagerstown, Maryland. He was referring to the main-gear indicator switches in system one. "They are too sensitive, and adjusting them can be tricky. I had one in here 50 times trying to get the lights to work right."

Alphin has a point. The gap between the downlock hooks and the proximity switches in the first system are supposed to be in the neighborhood of five- to ten-thousandths of an inch.

"And that's not all," Alphin continued. "The downlock hooks can become so worn that they will not stay engaged. You can adjust the downlock mechanism to compensate for wear, but sooner or later you will run out of adjustment. Then the wear causes slop in the tolerances, making it possible for the gear to come unlocked, causing no gear-down indication or making the pump run on. In the end, all you can do is replace the downlocks and then start over with adjusting the hooks and then the switches so that everything is aligned properly." The newer systems, Alphin said, have larger tolerances and are generally easier to work with.

Ken Cline, of Summit Aviation in Middletown, Delaware, has a more sanguine view. "Most of the problems I've seen with the downlocks not engaging involved dirt up in the switches or the mechanism itself. I don't think the airplane was really meant to be operated on dirt strips, but from the looks of some of them, they have been." Cline said that regular cleaning of the gear system's switches is the most important part of the RG's gear maintenance. As part of a Cardinal RG's 100-hour inspection, Cline said he spends about an hour just cleaning switches.

Cessna followed a learning curve of sorts in the development of the Cardinal RG's gear system. The company took the basic principle from the 210's gear system, but made the components lighter and relied on delicate, complicated electrical networks in the first systems. Slowly, the major problems were dealt with, but many still regard all Cardinal RGs as problem airplanes, claiming the gear system always will be a frail combination of unresolved, mysterious glitches. □