# Mooney 231

*Little things mean a lot when it comes to aircraft performance*

by EDWARD G. TRIPP
AOPA 308674
Photography by ROGER ROZELLE
AOPA 537321

Mooney aircraft have been noted for their efficiency from the days of the Mite, the first production airplane dubbed with Al Mooney's name.

The Mark 20 series seemed to have been developed as far as possible a few years back. About the only obvious thing left to do was to hang a bigger engine out front to increase performance. The laminar flow, flush riveted wings were clean—and beefy with their continuous, built-up spar. The development of the designs in the late sixties concentrated on creature comforts and better panel arrangemens.

Mooney has avoided the obvious however, and Vice President-R&D L. P. "Roy" Lo Presti and his crew popped the 201 on the marketplace in the fall of 1976. It was a big hit, and more than 800 should be in the field by the time you receive this issue.

It was careful attention to detail and continuing fine tuning, not more power and higher operating cost, that produced a big jump in performance that made the design competitive with a lot of big, high-priced iron.

The 201's airframe is clean; practically every area of disturbed airflow, from the windshield to the flap hinges, from cooling air flow to gear doors would seem to have been taken care of.

Then last November the model 231 (Mark 20 K) was introduced. It was preceded by a lot of talk about a turbosupercharged 201 as the next logical step; and, after all, seemingly every other lightplane design was getting the turbo treatment. Standard practice (admittedly oversimplified) has been to hang a turbo engine on the airframe, provide more cooling capacity and put it on the market. The result has been greater flexibility but little or no performance improvement over normally aspirated airframes of the same design below 10,000 or 12,000 feet.

The 201 is highly efficient and provides more performance per horsepower than any other production, four-place single. What's more, its service ceiling is 18,800 feet and we know from experience that it operates well in the middle altitudes. Mooney had a challenge created by its own success.

Lo Presti told us that one of the company's development methods is to establish performance goals and then figure out how to achieve them at a reasonable cost. They wanted a turbo version that would give good performance below 10,000 feet as well as provide the high altitude performance associated with superchargers. The first mark was to give nothing away to the 201, and that's about the only place where the objective was missed. The sea level top speed at its 2,900-pound gross is 172 knots (198 mph) versus the 201's 175 knots (201 mph) at 2,740 pounds gross.

## Improving the breed

The 231 retains the familiar Mooney shape, although the cowl is longer and squarer, and from certain angles it appears considerably longer than other Mooneys (but it is only 9 inches longer than the 201). It also retains good fuel efficiency for its performance capability.

The obvious move, to add a turbosupercharger to the Lycoming IO-360 that powers the 201, wasn't taken. The Continental TSIO-360 series engine, rated at from 200 to 225 horsepower in different versions, powers the Cessna Super Skymasters, the Piper Seneca and Turbo Arrow. The basic arrangement of the engine and accessories fits the nacelle of a twin better than a single and would have had to be mounted pretty far forward in the Mooney. That would have put a lot of weight out front, and would have required substantial changes elsewhere on the airframe (particularly the aft fuselage and tail).

Mooney and Continental worked together to rearrange accessories to achieve a more compact package. At the same time, the intake and exhaust systems were further tuned for better performance. Lo Presti engineered the air intake system, which is in the right air inlet, to slow down the flow and increase pressure in order to provide maximum delivery.

Quite a few changes were made to the airframe, too, to show that attention to detail can pay performance dividends, and to prove that Lo Presti is a fine-tuner *par excellence*.

During the 30-month development period, Lo Presti did a great deal of tuft testing. One result is a new wing root fairing or fillet. It adds about a knot in speed but causes stall characteristics to degrade somewhat. To maintain stall behavior similar to the 201, an additional stall strip was added to the leading edge of each wing; the modification has actually given the 231 better stall behavior.

The wing tips are completely new, sculptured fairings, which house the wing tip navigation and strobe lights. Tuft testing showed a fair amount of turbulent flow at the outer edge of the ailerons with Mooney's characteristic squared-off tips. The new approach adds better than a knot in speed and moves the tip vortices further outboard, improving aileron effectiveness. The design reduces adverse yaw to some extent as well, as it has the same effect as increasing wing dihedral.

Gaps between main and control surfaces were sealed even further. The


N231M


# Mooney 231

*continued*

after end of the bottom wing skin was extended to seal the lower leading edge of the aileron. The fairings on the inboard flap hinges were improved. Perhaps the most dramatic result of a seemingly marginal change was the nearly two-knot increase provided by covering the elevator and rudder attach bolts.

The search for performance has focused on the seemingly most minor protuberances. The battery cooling ram air tube has been made flush with the belly. The fuel vents, which are anti-icing to FAR Part 23 requirements, are flush, NASA-type ducts on the lower wing surface.

Not all the changes are ruthless, computer-derived results of the quest for performance, however. The first cowl design for the 231 did its job, but wasn't esthetically pleasing to Lo Presti. The culprit was the exhaust cross-over tube, which runs around the bottom of the front of the engine. Lo Presti scrapped the original cowl, added a beefy prop extension to provide more space (and design leeway) . . . and got a prettier front end.

In much the same manner, the fuselage-to-vertical tail fairing was changed. It didn't look quite right, so it was made longer with a sharper radius along the top. It is visually more pleasing but seems also to have helped the spin behavior of the 231, according to Lo Presti. The roof-mounted, ramp cabin air intake system was moved back to the port side of the fin. It, too, employs a NASA-type duct to reduce drag and lowers the cabin noise level when open compared to the old system. The juncture of the fin to the all-moving tail is tighter on the new design—one more small reduction in turbulent air flow.

## Tail feathers

Gross and basic empty weights of the 231 are 160 pounds heavier than the 201. Most of it is hung out front, which requires a balancing change at the rear. Lo Presti likes the basic design and structure of Mooney's distinctive tail and didn't want to make any fundamental changes.

However, the FAA has stringent requirements for demonstrating handling, particularly with respect to full aft trim, hands off stability in landing configuration and cruise pitch stability. To meet the two, somewhat conflicting, requirements usually means that down springs, bob weights and other artificial devices must be built in, particularly in aircraft with wide CG ranges.

The 201 has a system of four springs and four bungees, which was not easily adaptable to the 231. Besides, Lo Presti doesn't like the arrangement because of artificial control feel. The pilot feels the spring force rather than aerodynamic forces. Since the stability problem is most apparent during aft CG operations, Lo Presti changed to a variable rate spring in the 231. It functions during aft CG but is at zero tension in neutral to forward CG conditions, providing true aerodynamic feel most of the time.

To meet the cruise pitch stability requirements, a fixed trim tab of .032 aluminum has been added to the elevator to make the surface seek the proper attitude at cruise.

One additional change made to the control system is the addition of a six-pound bob weight, which is hung up behind the instrument panel. Lo Presti is not pleased with the arrangement, but stick forces per G were too light without it. The bob weight increases the effort to preclude overstressing the airframe (particularly during high stress situations, such as recovery from a spiral dive). Pilots flying the 231 will be using the trim to reduce control pressure. The factory has advised us that all the 231's made to date are

fitted with electric trim, a desirable option according to our experience in the airplane.

About the only part of the airplane that isn't smaller, smoother or sleeker is the cowl flap system. Two flaps drop on either side of the nosewheel. They're enormous, since they were designed for the worst case: high altitude, high temperature. While the attention paid to cooling air flow is very effective, there can be conditions other than ground running on hot days when the cowl flaps must be used.

The engine is designed and approved to be operated in cruise leaned to peak turbine inlet temperature (TIT), so long as it doesn't exceed 1,650°F. In situations where this value is reached, temperature can be reduced by reducing power, richening the mixture or opening the cowl flaps. Partially opened for low drag, the cowl flaps will reduce speed by 5 knots; full open they cost 14 knots.

Our evaluation flights in N231M were made during a period of very cold weather. We were using full cowl flaps on the ground since that is what the book calls for. In fact, the engine manufacturer's manual cautions about the possibility of creating hot spots in the engine as a result of uneven cooling air flow if they aren't used. It took a long time to get the recommended oil temperatures. (75°F for runup and 100°F for takeoff). Two operators suggested we leave the cowl flaps closed on the ground and partially open during takeoff and climb to keep the temperatures up. They claim the cooling system is so good that there is no problem with uneven flow.

On two occasions we had the dismaying sight of the oil pressure indication dropping while temperature approached the red line—in our experience, sure signs of an impending engine failure. Opening the hefty cowl flaps kept the two within reasonable limits, however, giving us a practical demonstration of their capacity. The problem has been attributed to an oil bypass valve in the oil cooler. It wasn't seating properly, sending heated oil directly back to the sump.

## Getting down to it

Procedures for preflight and start are straightforward. Mooney pilots will find the transition simple; non-Mooney pilots will find no tricks, just some different characteristics.

Preflight begins in the cabin. Some changes in here were introduced on the 201 first: the fuel selector has been moved from under the pilot's legs to the center of the cabin; the central pedestal has been trimmed down in favor of more knee room.

One change to the fuel system required by FAA will probably create more problems than the one it was intended to solve: a flapper valve at the top of each of the two filler necks to prevent fuel siphoning if a cap is positioned improperly. Fuel is trapped above the flapper, and a hasty check might leave the unwary with the impression that the tank is full when it could be empty, particularly at night. It is necessary to push the flapper down to visually check fuel, and it is doubly necessary to point the feature out to line personnel. We think it's Mickey Mouse, as does the factory. It will probably appear on other aircraft in the future and will increase, rather than decrease, the opportunity for fuel starvation accidents.

Mooneys sit low to the ground, and so does the crew. As with a sports car, you sit in it, not on it, with feet stretched out in front, way down under the panel. We like the intimacy with the airplane. In fact, about the only thing that doesn't square with the sporting image is ground handling. The turning radius is a wide 41 feet without braking. It takes a little getting used to and a little planning, although maneuvering, once underway, and normal taxiing are good. On the

# Mooney 231

*continued*

other hand, moving the airplane from the outside is easy. Easy, that is, so long as it isn't slippery: the tow bar is a too-short leftover from the 201 and doesn't extend far enough beyond the 231's spinner.

The only procedures different from the 201 are associated with the turbo system, and these are similar to any other turbosupercharged installation. The electric primer system installed on 231M worked effectively even during the coldest starts.

In fact, the only start problems involved the battery, and they weren't the battery's fault. The 231 has a Boeing 747-type, indirect cabin lighting system. Lights over the front and rear seats have three position switches (off, dim and bright), which add a useful and pleasant touch . . . and no glare. Unfortunately, the switch for the rear-seat lights is positioned for easy access from the baggage door. It's easy to hit the switch with a coat or bag without noticing it in daytime or on a brightly lighted ramp. One notices it when there is no electric power the next time. We were relieved to learn we weren't the only klutzes to drain the battery this way; 231 owners should make a light check part of the locking-up procedure.

Runup is straightforward. Ten degrees of flap are recommended for takeoff. Liftoff at 64 knots (74 mph) at gross weight and an initial climb at 95 knots (109 mph) get the 231 over a 50-foot barrier, no wind, in 1,600 feet; ground roll is 1,200 feet.

Both Mooney and Continental suggest maintaining full power (2,700 rpm/40 inches manifold pressure) throughout the climb. At our typical load factor during the evaluation (300 pounds below gross), using 100 knots, this produced average climb rates of 1,600 fpm vs. the book figure of 1,080 fpm at gross. Our usual climb power setting of 2,600/38 at 108 knots (125 mph) produced average climb rates of 1,150 fpm and better visibility over the nose. As with any fixed wastegate turbo system, manifold pressure must be monitored and adjusted during extended climb, although this installation seemed to produce less change than others.

The weather was consistent throughout our evaluation period: cold and rotten. The 231 proved to be a good instrument aircraft, stable and responsive. The climb capability proved useful several times when we wanted to get out of weather up into clear air.

The airplane we flew, 231M, is loaded with $25,000 worth of avionics and autopilot, right down to a telephone, and all are King Radio products. The KFC 200 Flight Director/ Autopilot system is truly deluxe (the only thing not coupled is a coffee maker). It includes a go-around mode to cue the proper pitch attitude.

The panel is intelligently laid out, the cabin is comfortable and it takes little time to feel relaxed with and in the airplane in flight. The only intrusion is the portable oxygen system nestled on the back seat.

Night lighting is good, and intensity is controlled by separate rheostats for the glareshield and the instruments. Reflection in the windshield and side windows is minimal.

Noise level is fairly high during full power, average at 75% and good at 65%. Vibration levels were minimal at rpm settings anywhere from 2,200 to 2,500 rpm.

The 231 is solidly responsive in all flight regimes. The aileron and elevator control pressures are somewhat high but produce quick results; the roll rate of the 231 seems higher than the 201. Rudder pressures are light. In fact, there is no rudder trim in the aircraft, and pressures required to center the ball in maximum performance climbs are very light. Cruise rudder trim, we have found, is obtained by lightly resting a foot on the left rudder pedal. It takes no conscious effort or pressure.

Stalls in all configurations and out of all attitudes are honest but without a great deal of buffet. There was no tendency to drop out of even accelerated stalls, and roll control right down to the edge of the stall is excellent. It is a very well mannered airplane to slow-fly.

We used 174 knots (200 mph) for descents. Manifold pressure held at 25 inches on the way down will give an average rate of 1,100 fpm and keep the cylinder head temperature in the green. Lower power settings for faster descent rates lower the temperature to the bottom edge of the green, and care must be taken to keep power settings below 20 inches manifold pressure until the head temperature rises after level off.

There are two procedures for emergency descent, both of which will produce 2,000 fpm or better. Clean, the aircraft can be dived at 196 knots (225 mph), which is right at the redline and should be used in calm air only. The same result can be obtained by slowing to 130 knots (150 mph) and lowering the gear, which provides a better cushion if rough air is encountered.

Pilots with experience in the 201, particularly the earlier aircraft in the series, will find the 231 requires a lot less work to land. Being low-slung, it too will float if the airspeed is high. However, in gusty conditions we regularly approached with more airspeed margin than necessary (85 knots rather than the recommended 75), then just let the airspeed bleed off—an area where the 201 would sometimes feel squirrely in gusts. There seems to be more elevator power, as well, despite the heavier weight out front. The early 201's had a tendency to drop onto the nosewheel too soon unless airspeed was just right and trim was practically full aft. There is no such tendency with the 231, and holding the nosewheel off takes no work.

Once on the main gear the aircraft slows quickly, with minimal braking (maximum braking takes a deft touch in both the 201 and 231 to avoid locking up the wheels).

We never felt the single landing light in the 201 to be inadequate and the dual system in the 231 proved out to be very good.

Any change in airspeed and configuration calls for pitch trim input. Dropping the gear at 130 knots (150 mph) gets the airspeed down to maximum flap extension speed (109 knots/125/mph) with manifold pressure at from 18 to 14 inches depending on load, and the change is eased if the electric trim is used throughout the maneuver. We sailed into the pattern at fairly high speeds several times to see how well the 231 can be slowed to pattern speeds. It is a very comfortable, orderly process with none of the fear of whistling on forever during an approach that one got with the early 201's (before gear extension speed was raised).

Go-arounds require anticipation, a fast thumb on the electric trim . . . or a lot of muscle. Landing gear extension or retraction creates little trim change, but extending or retracting the flaps, particularly with a simultaneous power change, creates a bunch. We should point out that this characteristic is well covered in the operating manual.

The operating manual is also full of power charts for performance and range, including a thick section on long-range settings for altitudes from sea level to the maximum operating altitude of 24,000 feet. The nautical miles per gallon attainable are most impressive, as are fuel burns, which can be brought down to 5.5 gph at 35% power.

We used 75% and 65% settings with best power mixture for all of our flights, ranging from altitudes of 3,000 to 17,000 feet. Corrected settings at 75% produced true airspeeds of 175 knots (201 mph) or better consistently, with fuel burns of 12.5 gph average. A setting of 65% regularly produced 165 knots (190 mph) at 9 to 10 gph. The engine is approved for regular operation at peak TIT of up to 1,650°F, which substantially reduces fuel consumption and extends range.

Lo Presti told us that they have been flying at best economy for more than 500 hours with no difficulty or concern, and they recommend using it. Suffice it to say that one has a lot of options in fuel flows, power settings, range and speed flying the 231. Familiarity with the aircraft and the many charts in the manual will pay off in utility, economy—and opportunities to brag during hangar flying sessions. The 231 continues the Mooney reputation for efficiency.

The useful load of 990 pounds in 231M leaves 552 pounds for payload with full tanks, or three FAA standard souls and 42 pounds of paraphernalia. With the Mooney's relatively long legs and a conservative climb power setting that permits leaning, trading off fuel for payload doesn't extract a big penalty in range. We note that the range figures in the operating manual are based on full-power climb to the selected cruise altitude, and no fudge factor is calculated for reduced fuel burn during descent. Some experience with the 231, careful monitoring of power settings, precise leaning and close fuel-use records can probably extend the book figures in actual practice.

### The Bottom Line

N231M is equipped with just about every available option, including a metallic silver paint job that turned a lot of heads wherever we travelled. Its list price is $85,135. The options add 110 pounds to the empty weight.

Mooney's pricing philosophy is, as the company's vice president-marketing, Donald K. Cox, told us, "competitive." That means the base price of $51,975 is bare bones, although it does include such things as zinc chromate and tinted windows, which are optional on many other aircraft. Mooney's "Operational Group" gets the 231 to a basic useful condition without avionics for $4,600 more.

The factory offers a wide variety of avionics options, with basic-to-deluxe King, Collins, Narco and Bendix packages and Edo-Aire Mitchell and King autopilot and flight control systems, including the KFC-200 already mentioned and the new Century 41 system. A basic IFR setup can be purchased for under $15,000, including DME and a basic autopilot.

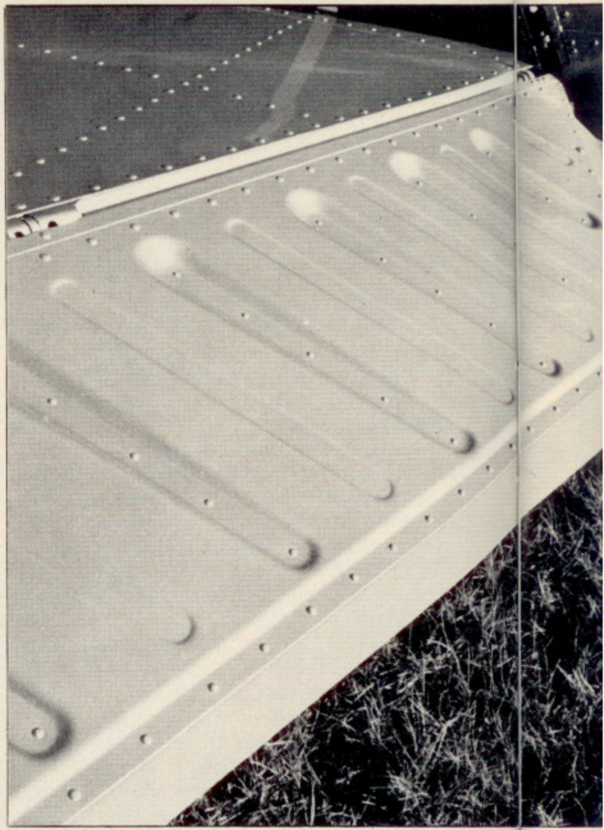
There are a lot of choices to fit the airplane to one's particular type of operation, and a very well-equipped 231 should list for about $75,000, without the soup-to-nuts treatment 231M has received (although we must confess we got very used to the deluxe system).

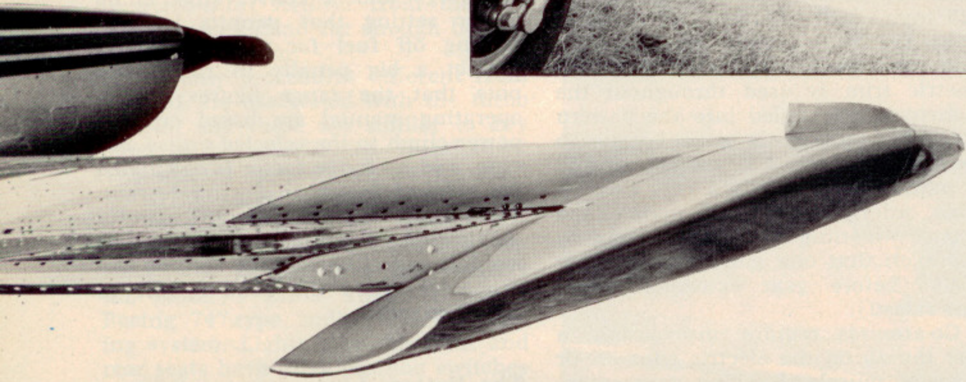
We think the company has succeeded in improving and extending the breed of fast, efficient singles with the new model. It is a solid, comfortable airplane to fly. It has been quickly accepted in the marketplace: nearly 100 orders had been received by the end of February. □

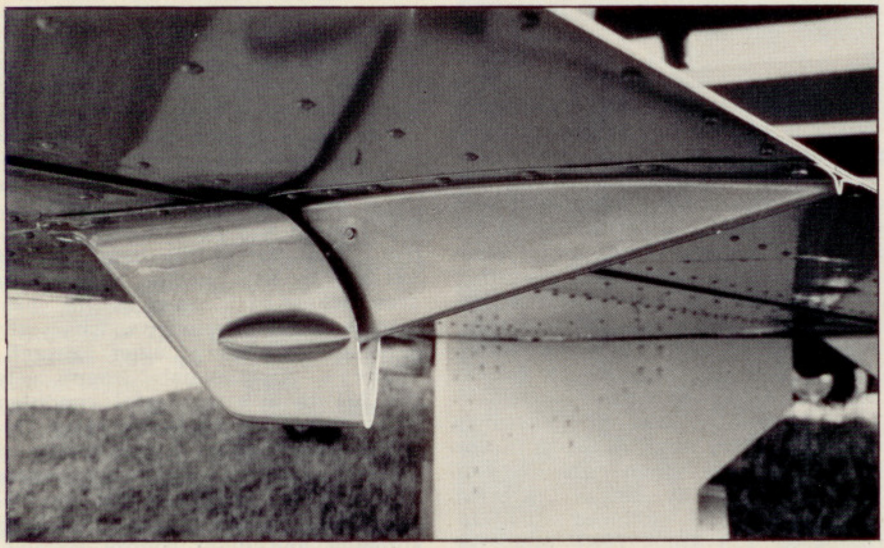
*continued overleaf*

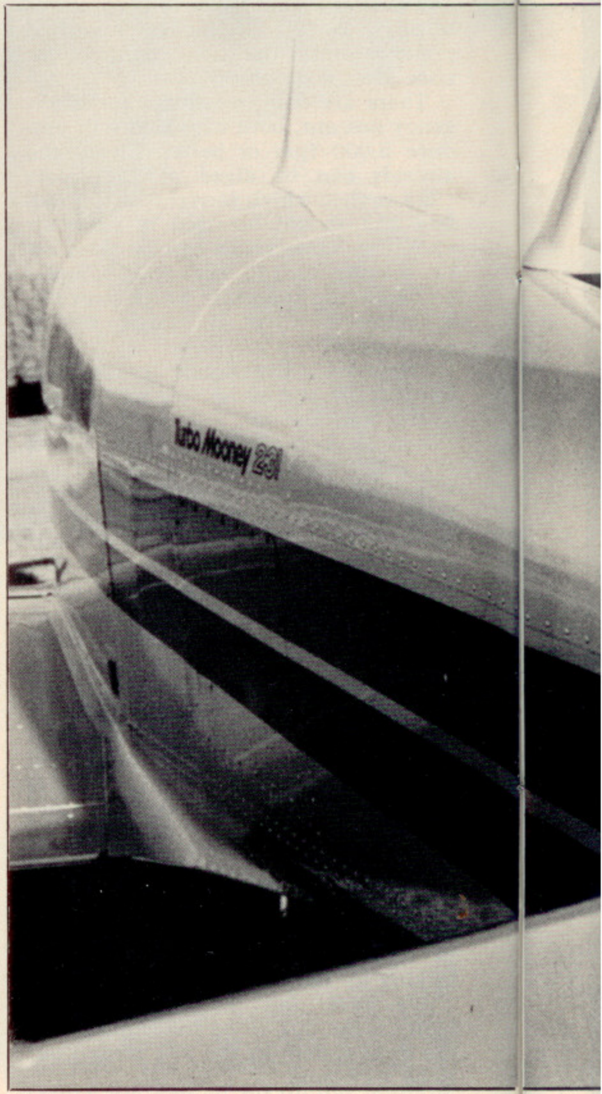
# Mooney 231

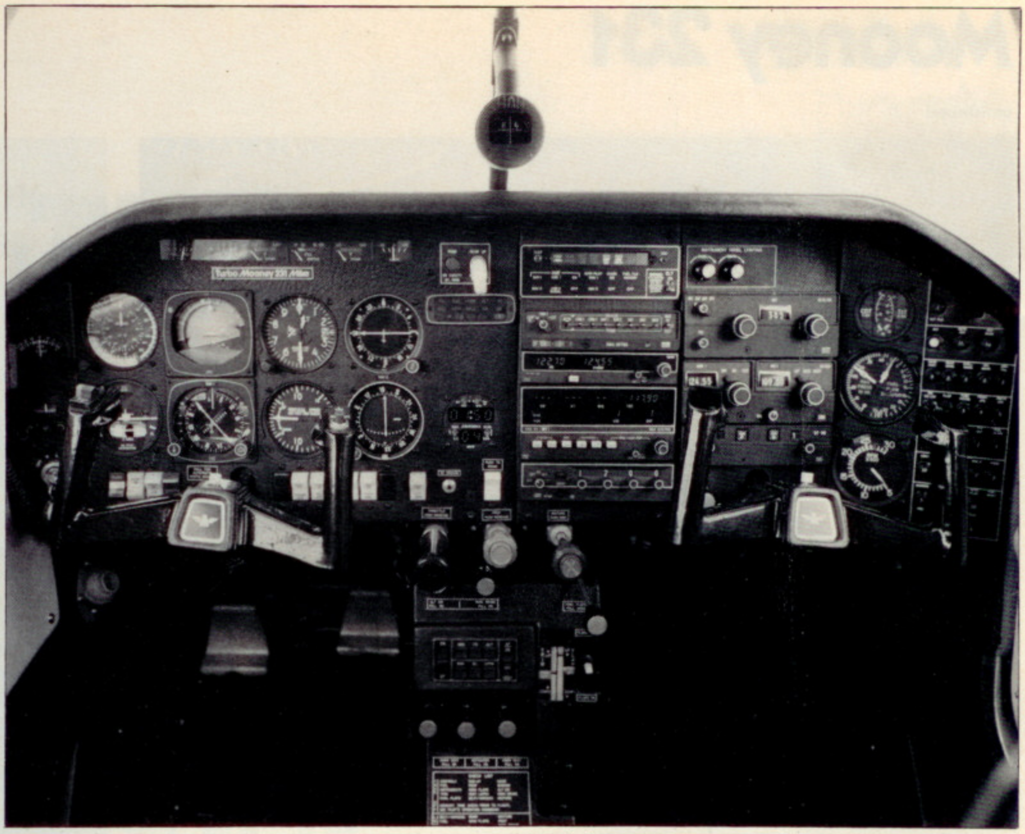
*continued*





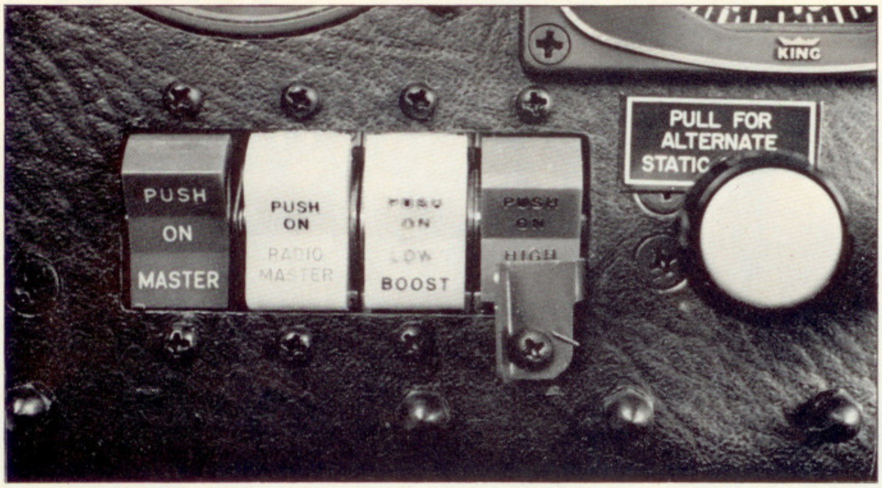


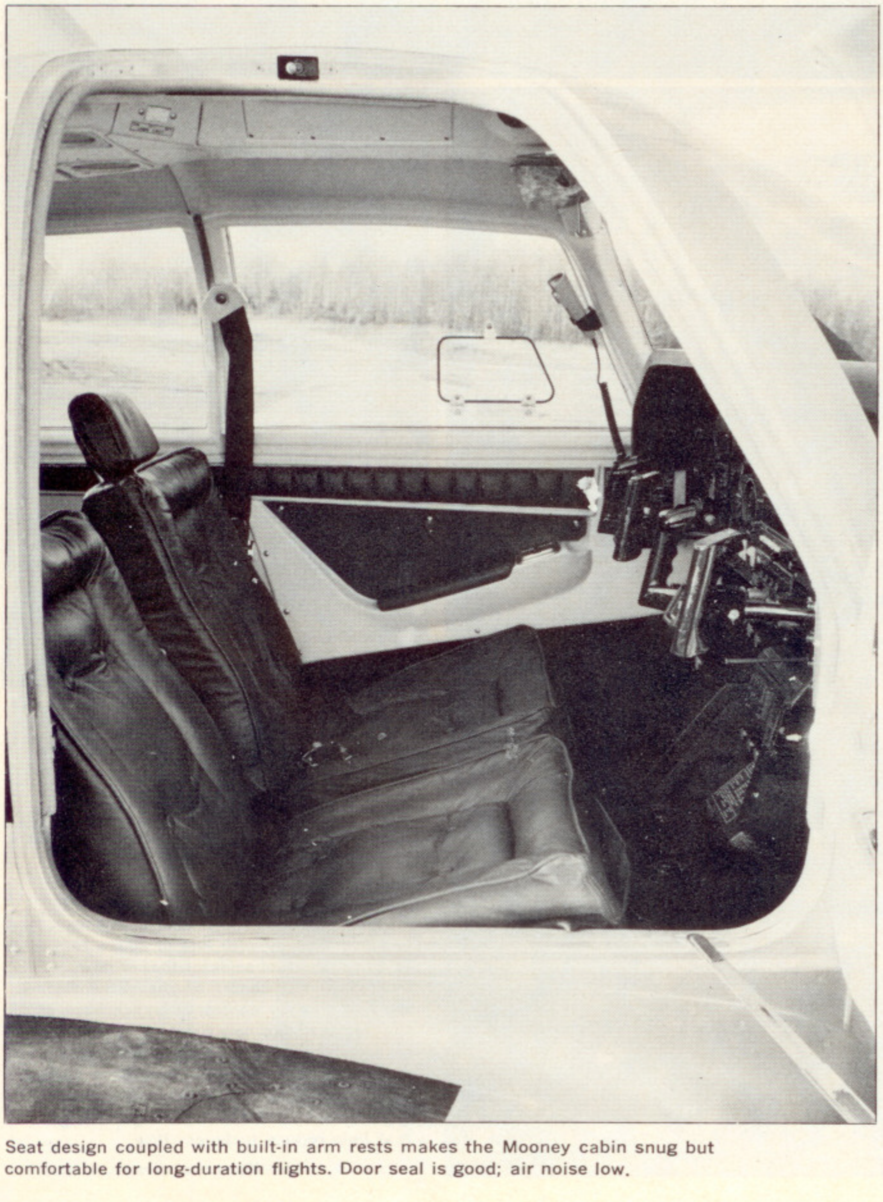




*Attention to detail is apparent in this pictorial walk-around. Clockwise from the silhouetted, sculptured wingtip that houses navigation and strobe lights, the details include: Huge cowl flaps that straddle the nose gear; the trailing edge of the elevator that sports a new, fixed tab. The gap between the horizontal stabilizer and elevator is carefully sealed, as are the hinges; the 231's panel that is roomy, familiar Mooney with lots of space for avionics; the fuel selector that is now located in the center of the cabin floor—the fuel strainer control is just in front of the left seat; the new fuselage to vertical stabilizer fairing that houses the cabin air intake; the complex main gear door system that contributes to higher performance when closed; and the flap hinge fairings that help reduce turbulent flow.*

*specifications continued overleaf*




Primary electrical switches are piano-type, arranged on either side of the control column. The electric boost pump is actuated by three separate switches: low boost is used if fuel vaporizes during high temperature, high altitude operations; high boost is used only if the engine-driven pump fails; prime (not shown) is used for starting.



Seat design coupled with built-in arm rests makes the Mooney cabin snug but comfortable for long-duration flights. Door seal is good; air noise low.

## MOONEY M20K 231

**Basic price $51,975**
**Price as tested $84,435**

### Specifications

| | |
|---|---|
| Engine | Teledyne-Continental TSIO-360-GB 210 hp @ 2,700 rpm, TBO 1,400 hr |
| Propeller | McCauley constant speed, 74-in diameter, 2-blade |
| Wing span | 36 ft 1 in |
| Length | 25 ft 5 in |
| Height | 8 ft 3 in |
| Wing area | 174.8 sq ft |
| Wing loading | 16.6 lb/sq ft |
| Power loading | 13.8 lb/hp |
| Passengers and crew | 4 |
| Cabin length | 9 ft 6 in |
| Cabin width | 43.5 in |
| Cabin height | 44.5 in |
| Empty weight | 1,800 lb |
| Equipped empty weight (as tested) | 1,910 lb |
| Useful load (basic aircraft) | 1,100 lb |
| Useful load (as tested) | 990 lb |
| Payload with full fuel (basic aircraft) | 662 lb |
| Payload with full fuel (as tested) | 552 lb |
| Gross weight | 2,900 lb |
| Fuel capacity (std) | 80 gal (73 usable) |
| Oil capacity | 8 qt |
| Baggage capacity | 120 lb (17 cu ft) |

### Performance

| | |
|---|---|
| Takeoff distance (ground roll) | 1,200 ft |
| Takeoff over 50 ft | 1,600 ft |
| Rate of climb (gross weight) | 1,080 fpm |
| Maximum level speed (sea level) | 172 kt (198 mph) |
| Maximum level speed (16,000 ft) | 201 kt (231 mph) |
| Cruise speed (75% power, 18,000 ft) Best economy mixture | 183 kt (210 mph) |
| Cruise speed (65% power, 24,000 ft) Best economy mixture | 187 kt (215 mph) |
| Cruise speed (55% power, 34,000 ft) Best economy mixture | 179 kt (206 mph) |
| Economy cruise speed (35% power, 24,000 ft) Best economy mixture | 134 kt (154 mph) |
| Range at 75% cruise (with 45-min reserve) | 960 nm (1,105 sm) |
| Range at 65% cruise (45 min reserve) | 1,060 nm (1,220 sm) |
| Maximum operating altitude | 24,000 ft |
| Stall speed (clean) | 62 kt (71 mph) |
| Stall speed (gear and flaps down) | 57 kt (66 mph) |
| Landing distance (ground roll) | 1,190 ft |
| Landing over 50 ft | 2,322 ft |