

SKYSHIP 500

Part submarine, part ship, part airplane, this Porsche-powered gasbag hopes to be the shape of things to come.

BY MARK TWOMBLY

Peter A. Buckley had flown innumerable piston twins to countless routine landings, but this was no ordinary twin, and it promised to be anything but a routine approach and landing. Buckley twisted the control wheel 90 degrees clockwise and, arms stiff, muscled it forward to the stop. The 12-foot rudder and 14-foot elevator swung to full deflection, forcing the aircraft into a descending base leg.

It came to a halt 150 feet over the ramp, 75 yards downwind of the ground crew. Annoying gusts and pesky late afternoon thermals buffeted the 16-foot-long airframe.

Buckley made the final landing check. Trim: check ballonet controls gauge. Ballonet fans: On. Dampers and air valves: controls aft. Prop pitch: select Forward Maximum Power. Vectors: horizontal or as required. Buckley figured the requirement at about 45 degrees and bumped the thumb switch on the control wheel to rotate the twin-ducted propellers to the desired angle. Final checklist item, temperatures and pressures: check normal.

Below, 11 men lined up in a V formation. At the apex of the V, which pointed into the wind, the crew chief held a small, white windsock aloft. The cylinder stood straight out, revealing a 15-knot breeze.

As the ship settled slowly toward the asphalt, Buckley used differential power and large doses of rudder to keep the nose pointed at the crew chief. A lapse in concentration could give the advantage to the wind, forcing the giant ship to weathercock.

On a cue from their chief, the ground crew broke formation and began running toward the aircraft. Half of them grabbed the ends of two thick ropes dangling from the nose and, like dock hands helping to berth a freighter, began reining in the beast. The others prepared to jump up and latch onto rails lining the outside of the cabin.



At about 30 feet agl, the ducted props swiveled to a vertical position and full power was fed to the engines to break the descent. Clouds of dust swirled from the ground as the single landing gear gingerly plopped onto the surface. Buckley cut the throttles and relaxed his grip on the yoke. The Skyship had landed.

Part airplane, part helicopter, part ocean liner and part submarine, the Skyship 500 airship is just that—an *air ship*. It helps if you have a conventional airplane pilot's license tucked in your wallet before climbing into the cockpit, but the pilot who has a sailor's feel for the wind and a sub captain's grasp of ballast is better prepared to undertake command of the Skyship.

Buckley can't claim undersea experience, but he is a sailor and airplane pilot, two skills that serve him well as chief pilot and manager of flight operations for Airship Industries Limited. The London-based firm has designed and built a new generation airship that uses lightweight composite construction materials and innovative propulsion techniques to achieve lower empty

weight, higher payload, greater maneuvering flexibility and less maintenance.

Two Skyship 500s are flying in the United States. A third is operating in England, and a fourth recently was constructed in Japan. Airship Industries also is test flying its first Skyship 600, a larger version of the 500, in England.

The Skyships are mounting a challenge to the Goodyear Aerospace Corporation's virtual monopoly over airship production. It's not that Goodyear has been waging a campaign to deflate potential competitors before they balloon, but, in nearly 60 years, no one has developed an airship that has competed successfully with Goodyear's designs or weakened its fierce dedication to its public relations blimps.

(Goodyear prefers the word blimp. It has an endearing sound crucial to fostering the image of the good, gray Goodyear airship as the gentle giant of the skies. The origin of the word is a matter of much speculation. Is it the sound produced when you thump the taut airship bag, or was it invented by the person who first slurred the name of an early lighter-than-air craft, the Type B-limp? No one knows for sure.)

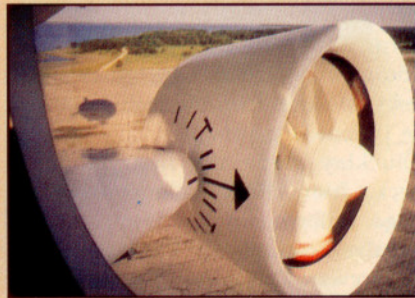
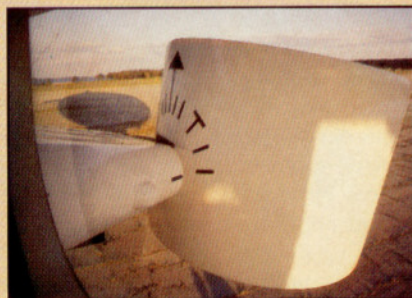
Are airships/blimps/dirigibles/zeppelins making a comeback? Will the military rediscover their marathon endurance? Will cargo haulers recognize their heavy-lift capability and paying passengers the silky smooth ride? These and other questions are posed with regularity by the true believers, airship devotees who bitterly argue that dirigibles have never been given the proper chance to prove their worth.

The airship's commercial potential was just beginning to be demonstrated in the late 1920s and 1930s by Count Ferdinand von Zeppelin's giant rigid dirigibles, the opulent *Graf Zeppelin* and the 804-foot-long *Hindenburg*. But the flaming crash of the *Hindenburg* on May 6, 1937, for reasons still unexplained, caused the public to lose faith



SKYSHIP 500

Ducted props and vectored thrust give the Skyship VTOL performance



in airships as airliners even though they had amassed a perfect safety record before the *Hindenburg* went down.

Today, when the Concorde is showing a profit, it is unlikely that low and slow airships will return in force as passenger aircraft. But Airship Industries is convinced there is significant interest in the airship as a surveillance, patrol and search and rescue aircraft, a delicate-instrument test platform, an anti-submarine warfare aircraft and a multi-purpose marine-science and geophysical research vehicle.

The list of military and government agencies that have conducted evaluations of the Skyship is long indeed: the U.S. Navy and Coast Guard; NASA; the French and British navies; the British Royal Air Force; the French Airports Authority; and British Aerospace. The U.S. Navy and Coast Guard have done initial flight testing on the Skyship 500 and hope to conduct extended operational trials with the larger model Skyship 600.

The advertising and public relations value of an airship has been well

documented by Goodyear, and, in fact, the initial interest in Airship Industries' Skyships is from advertising agencies. One of the U.S.-based Skyships will be orbiting Los Angeles this summer, displaying a bright green, white and red Fuji Films banner to thousands of Olympic spectators. An English firm is interested in leasing a Skyship fitted with a night sign, Goodyear-blimp fashion. A Greek shipping line is negotiating a lease of one Skyship 500 and two 600s, all equipped with electric billboards.

Goodyear is less enthusiastic about commercial prospects for airships. Its commercial fleet—32 airships over the last 59 years—is used only for in-house public relations. "We are aware of commercial interest worldwide," commented Fred R. Nebiker, division manager of business development for Goodyear Aerospace. "We have done marketing studies. We get a lot of inquiries, but we do not see a lot of opportunities."

Goodyear began building airships for the U.S. Navy 67 years ago. By 1960,

244 had been delivered to the Navy and 23 to the Army. If the military is struck with a fresh fascination for airships, Goodyear should be the first to know. So far, according to Nebiker, it hasn't happened. Still, Goodyear is prepared to participate in a military evaluation of its new GZ-22 (see "Clash of the Titans?", p. 70), should the Navy change its mind.

Meanwhile, Buckley is training a new generation of dirigible pilots, crew chiefs and ground crews. Home base for Buckley and Skyships 03 and 04 is a former Navy airship base in Weeksville, North Carolina, just south of the Elizabeth City Coast Guard air station on the banks of the Pasquotank River.

During World War II, the Navy deployed airships from Weeksville on sub-hunting and convoy-protection missions. The last Navy airship departed Weeksville in 1963, heading north to Lakehurst, New Jersey, and retirement. Twenty years later, the first Skyship 500 arrived.

Buckley and his crew were greeted with an improbable sight. A mixture of

small farms and expensive new river-side homes encroach on the old base. Two massive hangars tower over an expanse of crumbling asphalt and circular mooring pads overgrown with young pines. One of the hangars, built at least 50 years ago to harbor giant rigid airships, has since been converted to a furniture factory.

The second hangar was built during

World War II. It is made entirely of wood, except for its sheet metal roof, and stands 185 feet tall. Airship Industries leases half of it. The Skyship 500 can fit broadside in the gloomy interior. A farmer owns the hangar, along with most of the ramp.

It is here that Buckley trains young British pilots with multi-engine airplane and commercial ratings to become airship pilots. Students receive 25 hours of instruction, including at least one five-hour, non-stop, cross-country flight. They leave Weeksville qualified as copilots on the Skyship, which is not yet approved for single-pilot operation. After about 125 hours of on-the-job training, a copilot can be upgraded to a fully qualified captain. It's a rare distinction. Buckley, a former pilot on Goodyear's *Europa*, has logged 4,100 hours as pilot-in-command on airships. He is one of an estimated 30 airship captains in the world. "We hope to double that number by the end of the year," he said.

The pilot of a conventional airplane searching for something familiar in the hardware, operating principles or care of an airship will find little comfort. Close up, it is hard not to be intimi-

dated by the sheer bulk of the Skyship. Consider the vital statistics: length, 164 feet; height, 61 feet; diameter, 46 feet; volume, 181,200 cubic feet. Try parking *that* on a crowded FBO ramp.

To enter the Skyship gondola is to don a giant fedora. The view is of a vast hat brim stretching out before you, with three thin ribbons, the nose lines, dangling off the lip of the brim.

Pilots and passengers sit in perpetual shadow, a nice feature on those sweltering mid-summer training flights. Cabin air-conditioning is optional, but hardly seems necessary. If it's warm, simply slide open one of the picture windows and rest an arm on the sill. At the Skyship's 37- to 40-knot cruise, the breeze will be just right.

Turbulence is a discomfort unknown to Skyship occupants. There is no such thing as a bumpy ride. The bag and gondola bob and sway through turbulence as if floating over a succession of friendly waves. The pilot must wrestle with the controls to maintain a stable attitude in gusty conditions, but passengers are likely to be rocked to sleep after a few minutes aloft.

At first glance, the Skyship cockpit is deceptively orthodox. There's a famil-

Don't be fooled by the innocent-looking panel. Lurking overhead is a bristling array of switches, levers, pressure tubes and ballonet petcocks, which control spring-loaded valves.

Airship Industries Limited Skyship 500

Base price Aprx. \$2 million, plus \$500,000 for ground support fleet

Specifications

Powerplants	2 Twin Porsche 930/01/AI/2 six-cylinder air-cooled, electronic fuel injection and ignition, 204 hp at 5,900 rpm; 2:1 reduction Westland Lynx gearbox
Recommended TBO	est. 1,800 hr
Propellers	2 Twin Hoffmann five-blade variable pitch HO-V155A-R with 54-inch pitch mounted in annular propulsor ducts rotatable through 200 degrees
Recommended TBO	est. 1,800 hr
Length	164 ft
Height	61 ft 2 in
Diameter	46 ft
Envelope volume	181,200 cu ft
Seats	12
Cabin length	14 ft 2 in
Cabin width	7 ft 2 in
Cabin height	6 ft 4 in
Empty weight	6,460 lb
Gross weight	11,550 lb
Useful load	3,740 lb
Payload w/full fuel	2,000 lb
Fuel capacity, std	864 gal (804 lb usable)
	144 gal (134 gal usable)
Oil capacity, ea engine	16 qt

Performance

Takeoff distance, ground roll	0 ft
Takeoff distance over 50-ft obst	5 ft
Rate of climb, sea level	1,600 fpm
Single-engine ROC, sea level	1,000 fpm
Max level speed, sea level	55 kt
Cruise speed/endurance w/2-hr rsrv at full power	

(fuel consumption, ea engine)	
95% power	55 kt/5.6 hr (55 pph/9.2 gph)
70% power	40 kt/9.3 hr (33 pph/5.5 gph)
60% power	35 kt/10.5 hr (29 pph/4.9 gph)

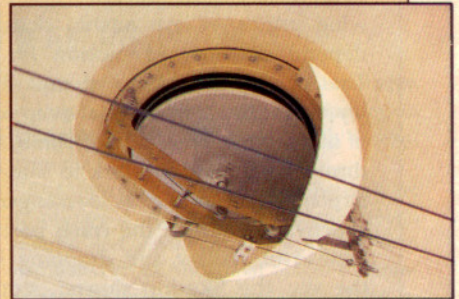
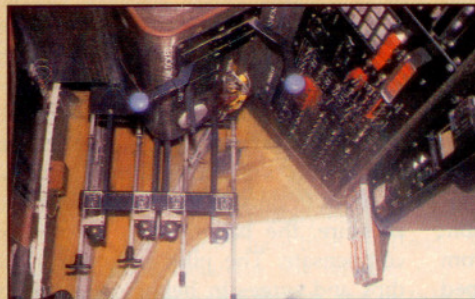
Design maximum ballonet ceiling	9,500 ft
Pressure height, at typical payload	4,000 ft to 4,500 ft
Landing distance over 50-ft obst	200 ft
Landing distance, ground roll	0 ft

Limiting and Recommended Airspeeds

Vmc (Min control w/one engine inoperative and the other at full power)	10 KIAS
Vsse (Min intentional one-engine inoperative)	0 KIAS
Va (Design maneuvering)	45 KIAS
Vne (Never exceed)	55 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.





iar-looking yoke, used for pitch and yaw control, and even a suite of IFR avionics and flight instruments. A closer inspection turns up plenty of strange gadgetry: the four ballonnet control valves hanging to the left of the pilot; damper levers positioned overhead; a helium pressure gauge calibrated in inches of water; variometer; and a vector angle indicator.

Airplane pilots making the transition to an airship must unlearn a few fixed-wing principles. An airship does not depend on forward motion for lift. That became clear the first time Buckley took off, established a steep angle of attack for a brisk rate of climb, then throttled the engines back to idle. The airplane pilot riding as passenger instinctively assumed the crash position. Instead of stalling and dropping from the sky, the Skyship slowed, stopped and hung motionless, its nose still pointing at the sun. A slight grin crept onto Buckley's face as he advanced the throttles and resumed climbing.

An airplane pilot sets pitch trim by adjusting a tab on the elevator. Not so in an airship. Inside the bag, there are two ballonets (bal-a-NAYS), or inflatable air bags. One is located forward of the gondola, the other aft. When fully inflated, the ballonets fill 26 percent of the volume of the envelope. Air is fed to the ballonets from scoops positioned behind the propellers. Inflating a ballonnet displaces helium, and thus the lifting medium, to the opposite end of the bag. If the airship is nose heavy, the pilot vents air from the forward ballo-

net and at the same time inflates the aft ballonnet. Helium is displaced from stern to bow, and the nose rises.

Ballonets also are used to maintain optimum helium pressure inside the envelope. Airship envelopes are non-elastic, and when filled with helium the internal pressure will only be about .05 psi greater than atmospheric pressure. (The pressure differential is so small it can't be measured accurately with mercury-based pressure gauges. Instead, airship pilots rely on gauges marked in inches of water. The correct pressure reading for the Skyship is between 1.35 and 1.5 inches of water.) Since helium is highly susceptible to expansion and contraction due to changes in outside air temperature and pressure, the ballonets are needed to compensate. The pilot counteracts the dips and surges in helium pressure by inflating or deflating the ballonets.

An airship pilot scanning a beautiful blue summer sky flecked with puffy white cumulus clouds sees only a work-intensive flight ahead. When the sun ducks behind a cloud, the helium in the bag cools and contracts. The pressure in the bag begins to fall, and the pilot must inflate the ballonets to compensate. Then the sun reappears. The helium warms and expands. The pilot now must vent air from the ballonets. Minutes later, the airship wanders into the shadow of another cloud, and the process begins again.

Non-rigid airships, the only kind still flying, have changed little since 1925, when Goodyear first assigned one of

its Navy L-1s to public relations duty. Airship Industries hasn't tampered with classic non-rigid design principles, except in the way they are constructed.

To reduce the empty weight of the airship, Airship Industries makes extensive use of composite materials in the gondola, control fins and rigging. Kevlar cables suspended from the roof of the bag support the molded two-piece Kevlar/epoxy gondola. The tail-fin ribs and spars are made of Fiberlam honeycomb, which is resin-coated Aramid sandwiched between layers of fiberglass/epoxy skins. The leading edges of the fins are covered in Kevlar, and the rest of the fin surfaces are made of Tedlar. The rudder and elevator are Fiberlam frames covered with Ceconite. Kevlar is used in the nose cone and battens.

The Skyship envelope, which is made in France for Airship Industries, consists of an inner gas retention film, a layer of polyester and an outer coating of titanium-oxide impregnated polyurethane.

Two Porsche six-cylinder air-cooled engines power the Skyship. Porsche developed the three-liter engines, which are based on the Porsche 911SC automotive engine, for Airship Industries. The electronically fuel-injected engines develop 204 horsepower each at 5,900 rpm. At cruise settings, each of the Porsches consumes less than five gallons of 98 octane autogas or 100LL avgas. The engines are encased in titanium-lined compartments in the rear of the gondola.

Five-blade reversible Hoffmann propellers are mounted inside Fiberlam-and-Tedlar-covered annular ducts located on pylons outboard of the en-





SKYSHIP 500

*There is no such thing
as a bumpy ride*

gines. Gearboxes borrowed from Westland Lynx helicopter tail-rotor drive systems transfer power from engine-driven shafts to the propellers. An electric motor rotates the propeller ducts through a 200-degree arc, 110 degrees up and 90 degrees down.

Vectored thrust enables the Skyship to take off and land in confined areas and, in a headwind, maintain a near hover. Airship pilots prefer a moderate headwind over calm conditions when landing or loitering. With no wind or forward speed, no air passes over the control surfaces.

The Skyship is less an airship than an organization. Airship Industries will sell you a 500 for about \$2 million, but the Skyship is helpless without another \$500,000 investment in a proper ground support fleet: a heavy mobile-mast truck; a pickup truck fitted with a smaller back-up mast; two nine-passenger vans to transport the ground crew; two jeeps for the pilots and technicians; and an engineering van that serves as a rolling workshop.

Skyship operators will need lots of friends as well. Airship Industries recommends that operators have a 23-person support crew on hand for the first 200 hours of operation. With experience, the crew can be trimmed to 18. In a really lean operation, technicians can double as rope handlers so the payroll can be reduced to 11 people, plus pilots.

Crewing for an airship is hard work. The day begins early and continues until after sundown. Only when the

Skyship is safely pinned to the mobile mast, pivoting in the evening breeze, does the duty end. Even then, two crewmembers must keep an all-night vigil from a tiny box on the back of the mast truck. The bag pressure must be monitored constantly to prevent the Skyship from going soggy.

Despite the work, turnover is not a problem among Airship Industries' ground crews, most of whom are recruited from the local area. There is, after all, some social stature to be gained from telling the neighbors in Weeksville and Elizabeth City that you crew for the biggest ship south of Norfolk. □

NEW AIRSHIP REGS

No more rubber stamp for the big bags

Dirigibles have been flying for about 130 years, but the Federal Aviation Administration is just now getting around to developing certification standards for them.

The only American-made airships that have been flying non-military missions regularly in this country have been the Goodyear blimps. Goodyear has received two type certificates for its airships, one in 1935 and a second in 1948, but the certifications were based on the U.S. Navy's approval of the designs. Since Goodyear's commercial airships were derivatives of designs Goodyear developed for the Navy, the FAA and its predecessor agency were content with simply rubber stamping the Navy specifications. No one else was asking for civilian certification of an airship, so the FAA never bothered to come up with standards.

That has changed. The FAA now has applications for airship type certificates from four different companies: Goodyear for its new GZ-22; Airship Industries for the Skyship 500; Westdeutsche Luftwerbung (WDL), a West German company that has built and is operating two airships based on the Goodyear GZ-20 bag, but with a differ-

ent gondola; and Grace Aircraft Corporation of Eugene, Oregon. Grace is proposing to build the GAC-20, which reportedly is similar to the Goodyear GZ-20.

FAA officials have been working on a set of proposed standards for about seven months, and a draft of their work has been distributed to FAA regional offices for comment. If accepted, the standards will be issued in the form of an advisory circular, much like certification standards for gliders. The Federal Aviation Administration also will seek an addendum to Federal Aviation Regulation Part 21, since no regulatory basis currently exists to issue standards on which to base airship type certificates.

The FAA's airship standards were developed in consultation with lighter-than-air experts at the National Aeronautics and Space Administration. The standards borrow heavily from FAR Part 23, which governs certification of airplanes weighing less than 12,500 pounds. If the draft standards pass muster within the FAA, the rule change will be published in the Federal Register for public comment, and the advisory circular could appear this fall. —MRT

"Clash of the Titans?" overleaf

CLASH OF THE TITANS?

Goodyear and Piasecki rise to their competition.

What has the world's foremost builder of airships, Goodyear Aerospace, been doing while upstart Airship Industries turns out Skyship 500s and 600s?

Plenty. Goodyear has designed a new commercial airship, the GZ-22. Due to fly late in 1985 or early 1986, the GZ-22 will have many of the same features found on the Skyships, but with a few twists.

The vintage welded steel-tube and aluminum-skin gondolas that have been on all of Goodyear's airships will be replaced by a lightweight carbon graphite gondola on the GZ-22. The tail fins will be in an X configuration for increased ground clearance on high angle of attack takeoffs and landings.

Goodyear will stick with its traditional envelope construction, a layer of butyl and neoprene sandwiched between layers of rip-stop polyester fabric. The combination is as light as the Airship Industries envelope, but more resistant to osmosis, or the breathing of helium through the bag and into the atmosphere, Goodyear claims.

Like the Skyships, the GZ-22 will have vectored thrust for greater maneuverability. Unlike the Skyships, the GZ-22 will be powered by turbine engines. Goodyear has said it plans to use a pair of 420-hp Allison 250 series turbines mounted inside annular

ducts directly behind five-blade composite construction propellers. The engines will rotate with the ducted props. The unique installation is intended to reduce the weight and complexity of the power train, while the turbine engines should reduce noise. Goodyear's current airship, the GZ-20, produces an 86 decibel noise footprint on the ground with both engines at cruise power. The turbine-powered GZ-22 should whisper along at 76 decibels, according to Goodyear.

Not only will the GZ-22 be a friendly neighbor to folks on the ground, but a quieter ship means happier passengers, including the television camera operators who orbit over major sports events courtesy of the Goodyear blimps.

The GZ-22 cockpit will represent a half-century leap in technology for Goodyear airships. The GZ-20's cumbersome pitch control—a large helm-like wheel positioned between the crew seats—will be replaced by a yoke. There will be dual controls, and the right hand yoke will fold away when the seat is occupied by a passenger.

The GZ-22 also will have an electronic fly-by-wire control system, with a mechanical backup. The heavy control forces common to current airships will be reduced to about five-pound forces in the GZ-22.

Goodyear's first commercial airship, introduced in 1935, was simply an L Class design that Goodyear had developed as a Navy trainer. The envelope measured 149 feet in length and held 123,000 cubic feet of helium. It was replaced by the GZ-19, which had a volume of 147,000 cubic feet.

In the late 1960s, Goodyear designed the GZ-20, a stretched version of the GZ-19 and in the early 1970s replaced its fleet of GZ-19s with the new 200,000 cubic foot GZ-20s. The GZ-22 will hold 225,000 cubic feet of helium and cruise at 65 mph maximum, compared with the GZ-20's 50 mph. The useful load will go from the present 3,600 pounds to 4,400 pounds, for a payload of 2,200 pounds—400 pounds greater than the GZ-20. The GZ-22 will be 198 feet long and 48 feet in diameter. It also will have an improved electronic sign on its flanks.

The GZ-22s will be phased into the Goodyear blimp fleet gradually. Goodyear depends on the commonality of its fleet to keep maintenance activities and parts inventories as efficient as possible. Switching over to the fourth new commercial airship design in about 60 years will be a significant logistical undertaking for the company.

There is one other airship project underway in the United States. This fall, pioneer helicopter designer Frank N. Piasecki hopes to make the first flight of the Heli-Stat, a hybrid helicopter/airship heavy-lifter.

Seven years ago, Piasecki was awarded an \$11.8 million contract to build a proof-of-concept Heli-Stat for the U.S. Forest Service. The contract has since been increased about 80 percent. The Heli-Stat concept is deceptively simple. Four Sikorsky SH-34J helicopters, their tail booms and rotors replaced by pusher props, are attached to a spidery metal interconnecting structure that is attached to an airship. The airship lifts the entire structure off the ground to a working altitude, freeing the combined 6,100 horsepower from the helicopters to lift external cargo.

Piasecki has been building the prototype in one of the old airship hangars at Lakehurst, New Jersey, and at press time was preparing to mate the interconnecting structure with the airship, which is a 343-foot-long Navy surplus ZPG-2. If all goes well, by October test pilot John Anderson, who will be sitting in the left rear helicopter, will apply power, raise collective (power and flight controls on all four helicopters are interconnected by cable, so Anderson will be the only pilot) and fly. If the prototype is successful, production versions could sell for between \$12 and \$30 million to loggers who are in the market for something that can pick up and run with 24 tons of freshly cut lumber.

—MRT



Goodyear's new GZ-22 will have turbine engines and vectored thrust. Frank Piasecki is building a heavy-lifter from four helicopters and a surplus Navy airship.

