With pedals and spokes

and balsa wood, three British airplanes

seek to conquer the problem of . . .

Man-powered Flight

By DARYL MAY

BY AERO-ENGINE standards, the human body is simply a bag of bones. It is complex, bulky, inefficient and extraordinarily heavy for the power it produces. And it suffers from special shortcomings of its own—such as fatigue and laziness. You would not think any airplane designer would succeed with an engine like this. And, until just recently, none ever did.

Man-powered flight has always been one of man's more utopian dreams, but the realization of the dream has been along a far from utopian path. It is said that in 1400 B.C. Icarus tried the wax-and-feather approach, but high-temperature conditions modified the design in flight and the pilot was lost. Leonardo da Vinci had some very artistic designs, which, fortunately for the test pilot, were never built. And Otto Lilienthal, birdman of the last century, killed himself in glider tests. By 1930, after a thousand stories of failure, people were inclined to agree that man-powered flight was strictly for the birds.

Then in 1935-37 came two airplanes which proved the possibility of man-powered flight. Both were catapult-launched and it is not certain that either ever took off under the power of its pilot alone. But, catapult-launched, the German Haessler-Villinger machine flew 700 yards in a straight line and the Italian Bossi-Bonomi about 1,000 yards over a near-rectangular course. Man-powered flight was in the books and the achievement of unassisted takeoff followed by long-distance flight seemed only a matter of development.

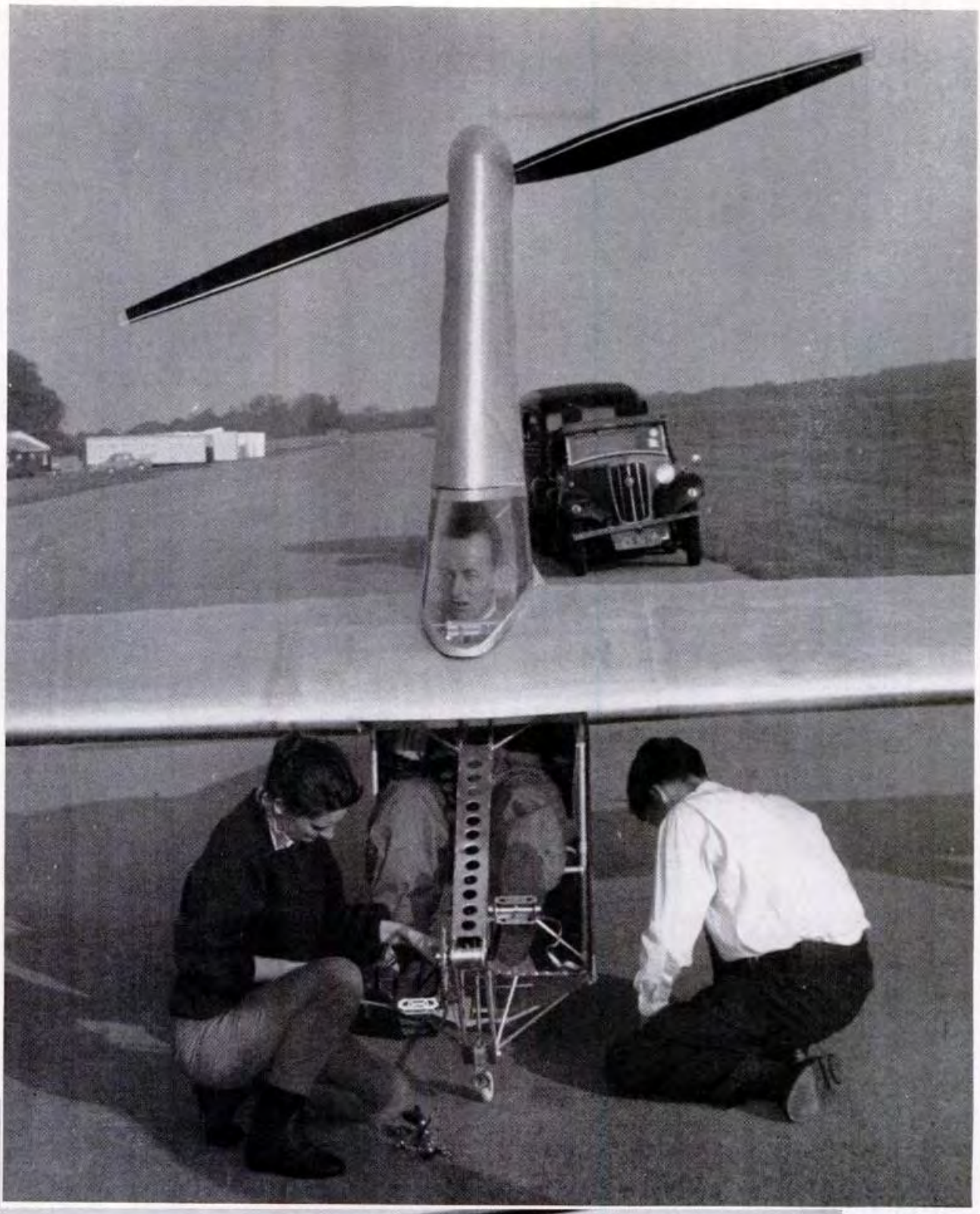
Here the story would have ended were it not for a sudden and intense resurgence of interest shown by the British in the last few years. The Grand Ideal had always been present, but the spur had not been until November 1959 when industrialist Henry Kremer offered £5,000 ($14,000) to the team that first constructed an aircraft which, without the use of lighter-than-air gases or devices for storing energy, took off under the power of its crew alone and flew a figure-eight course around two posts a half-mile apart, beginning and finishing at a height of over 10 feet. The course is, in effect, a means of proving the ability to take off, turn and fly a reasonable distance. Additionally, Kremer stipulated that the designer, entrant, pilot and land of construction and flight must be British.

In June 1960, soon after the announcement of the Kremer competition, the Royal Aeronautical Society's recently-formed Man Powered Aircraft Group expressed its willingness to provide financial assistance to teams submitting promising design studies. After evaluation of many submissions, including some rather hopeful flap-wing and helicopter projects, the Society made grants to help build three airplanes:

- SUMPA (Southampton University Man-Powered Aircraft), a one-place machine designed and built by students in the laboratories of the Department of Aeronautics and Astronautics of this British university. A grant of £1,500 ($4,200).
- *Puffin*, another one-place airplane, designed and built by the Hatfield Man Powered Aircraft Club, assisted in every way by de Havilland at Hatfield. Brain behind the scheme is John Mimpenny, de Havilland's Assistant Chief Designer. Grant is also £1,500.
- Southend Man Powered Aircraft Club's courageous two-place design by a group of engineering workers with no help beyond a grant of £750 ($2,100).

One basic equation related the varying approaches of the three teams—the power of the human body. Man may indeed be a bag of bones, but information is remarkably scant on just how inefficient he is. All three teams did considerable re- (*Continued on page 94*)

Below: Southampton University man-powered aircraft aloft. *Right:* Aircraft designers Anne Marsden and Alan Lassiere make last-minute preflight checks.



Copyrighted material

(Continued from page 93)

But what's this? He's bigger than ever!

So you learn that you must watch your temperatures and altimeter, maintaining a given altitude by controlling the volume of hot air the burners put in the balloon. Eventually you'll hit a combination that will keep you in reasonably level flight. You will also learn to "lead" the balloon, allowing time enough for the hot air volume to increase for climbing, or to decrease for descent. The required lead time will vary with changes in the ambient temperature.

Landing the balloon can be as gentle as a hen sitting on eggs, or it can be a series of affairs, all unpleasant. When you have served your apprenticeship, like Piccard and his ilk, you will, usually, be able to select your approximate landing spot. You'll coordinate your ground speed with the rate of descent, so that the balloon arrives over your target area about five feet above the terrain. At that instant you'll close the switch and blow the squib, dropping gracefully to the ground as you do so, thereby avoiding being smothered by the collapsing balloon.

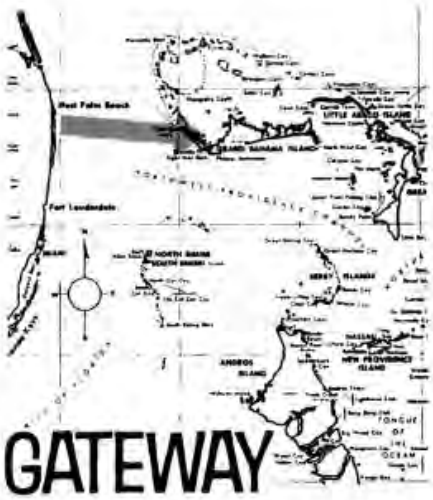
However, if you are like the members of the American Montgolfier Society, it won't be at all like that. You'll make an average of three attempts before accomplishing a landing, and then you'll be dragged a bit before you blow the squib and collapse the balloon. This is disheartening if you are in a pasture well populated with cows, and worse if hedges, brush, trees, ponds, or barbed wire fences are your lot.

Well, you ask, why not blow the squib before landing, as Piccard does, and avoid being dragged?

Because, friend, Piccard also says that it is quite a while before you accurately can judge your height above the ground; and if you should blow the squib at 50 feet, thinking you're at five . . .

The balloon has become the final segment of my circle—perhaps the brightest link of all. As for the harried members of Miller's Mob, formally known as the American Montgolfier Society, they are about to be flanked by hundreds of members of similar clubs everywhere, as sport ballooning crests on the great wave of popularity now beginning to surge.

So happy landings—and don't blow your squib too early! ✚



GATEWAY TO THE BAHAMAS

Just 65 miles from West Palm Beach, your shortest over-water flight, you enter the fabled world of the Bahamas.

At the Jack Tar International Airport you'll land on a modern 6200-foot runway. The airport is a Government Port of Entry, with customs and immigration. Facilities include radio control tower Unicom (122.8 megacycles), complete fuel service, tie-down. Licensed A.E. mechanic available. The field will easily accommodate anything from a Cub to a Viscount, and if your ultimate destination is another island, expert navigation assistance is yours for the asking.

Grand Bahama is definitely your logical gateway to the Bahamas. And while you're there, enjoy yourself — stay at the Grand Bahama Hotel.

WEST END, GRAND BAHAMA ISLAND, BAHAMAS

GRAND BAHAMA HOTEL AND COUNTRY CLUB A Jack Tar RESORT

Ask your Travel Agent, or write Dept. G263, P. O. Box 59-2375, Int'l Airport, Miami. THE BAHAMAS' COMPLETE RESORT — Golf (18 hole private course). Deep Sea Fishing (our own Marina, boats, tackle), Skin Diving, Pool and Ocean Swimming. Tennis. Bowling. 9-mile Private Beach. Children's Activities. Bargain Shopping. and lots more.

Man-Powered Flight

(Continued from page 36)

search on the problem and stimulated work by others in this field. It was found that for a short period of perhaps three minutes, a man can make use of energy stored in his muscles, but that even a champion athlete could sustain only about .6 hp. When you realize that an efficient modern sailplane needs about four hp for straight and level flight, it is obvious that very severe problems needed overcoming. The secret of success is clearly to design a lightweight structure, strong enough to carry the loads but not too strong. Reinforcement by way of overstressing might make for higher structural strength but it brings a weight penalty that has to be avoided. Although each of the three aircraft has a wing span more than twice as great as a Cessna 310's or an Aztec's, none of them weighs more than 140 pounds empty—one-twentieth as much.

The Southampton machine was the first to fly.

Alan Lassiere, Anne Marsden and David Williams were all final-year undergraduates when they decided to launch SUMPA.

The ribs and spars are made mainly from spruce and balsa; the ribs of girder construction and the spars multilaminated using one of the five different glues used on the airplane. The wing is made in three sections joined by aluminum alloy fittings glued to the wood. Covering is by parachute nylon, doped silver to protect the structure from ultra-violet light.

An aspect ratio of 21.3 shows how slender the wing is. With its span of 80 feet, the wing-loading is remarkably low—.90 pounds per square foot. The centersection is 20 feet long and bolts directly to the upper part of the fuselage. The outer sections, each 30 feet long, have a slight dihedral and carry the 20-foot-long ailerons. There are no flaps.

The pilot and power transmission system defined the shape of the fuselage. Either you have good visibility and too much frontal area, reasoned the designers, or bad visibility and low frontal area. And you have to find a position for the pilot so that he can pedal comfortably. Eventually they compromised and put the pilot in a semi reclining position, leaning backwards. He has a backrest which provides the reaction for his legs, leaving his arms free for controlling the airplane. He sees through a window in a vertical pylon which is the support for the pusher propeller mounted above and behind the wing.

Fuselage features spruce longerons; its four sides are built up on the flat just like a model airplane's and assembled around a few frames. The cockpit is made of aluminum alloy tubing. At its front end is an eight-inch sprung nosewheel; just behind the pilot is the main undercarriage in the form of a 27-inch bicycle wheel.

Transmission from the pilot's pedals to the propeller needed special study. Because the propeller was most efficient around 20 mph and most inefficient at lower speeds, it was necessary to power the airplane up to takeoff speed through the bicycle wheel. The transmission, therefore, went from the pedals to the wheel, then up to the propeller.

Pedals are designed to turn 90 rpm, giving a propeller speed of 260 rpm.

Because the pilot needed his legs for pedalling, the rudder controls had to be incorporated into the hand-controls. Besides a normal forward-and-back movement for elevator and left-right movement for aileron, the control (a horizontal bar) can be swivelled about a vertical axis like a foot-operated rudder bar. Nylon-covered steel shark-fishing wire operates the control surfaces.

SUMPA was built in the evenings and weekends through 1961 and was taken to the big Lasham Gliding Centre by trailer in September. Would it work?

The question was no laughing matter by then because the project had progressed

beyond the pocket-money stage to one where other people's facilities and money had been freely used. Additionally, some of the team—most had by then graduated with B.Sc. degrees—were planning to submit for M.Sc. degrees on the basis of their research into man-powered flight.

The designers had calculated that to cover the figure-8 of the Kremer course they needed a pilot who could produce .55 hp for one minute on takeoff followed by .45 hp for another four minutes. But there was one big unknown: they were not sure how much help they would get from the ground effect, by flying less than 15 feet high and benefitting from the "lift-sandwich" between wing and ground. Pilot on the first flight was Derek Piggott, Chief Gliding Instructor of the biggest gliding center in the country.

They wheeled out SUMPA for initial taxi trials after waiting for a day that was absolutely still. Under each wing was a loop of wire to prevent it from touching the ground. The first trials were marked by four frustrating though not serious accidents. The cycle chain came off. The bicycle wheel got a puncture. Load on the pedal bent the aluminum frame which had to be straightened and strengthened. Then in a "high-speed" taxi run, the airplane swung off the runway, damaging the nosewheel and front framework.

Finally, at 4:30 p.m. on 9 November 1961, Derek flew 50-70 yards at an altitude of about 5 feet.

Film of the early flight trials showed that the mainwheel was slipping repeatedly just before the airplane climbed away. This meant that the wheel had provided flying speed before the propeller was going fast enough to take over. The gear ratio was altered and flights on 24 and 25 November proved the trouble had been overcome. The airplane flew 30 seconds and 300 yards.

The test program of any revolutionary airplane brings to light many unexpected problems. There was little experience of flight at 20 mph and the lack of feel coupled with control friction made SUMPA difficult to fly. They tested various improvements by towing the machine behind a car.

Derek found difficulty in turning, despite the fact that up-aileron movement was twice as great as down-aileron (to increase drag on the side he wished to turn). So they improved the turning qualities by increasing rudder area.

Soon SUMPA was flying over 650 yards.

Only eight days after SUMPA's first flight, the de Havilland team at Hatfield flew *Puffin* for the first time. During the long months of design and construction the Hatfield club had been working in great secrecy; yet each team was aware of the other's efforts, and each was competing for the prize.

Despite the independent approach of the teams, the same decisions were reached on the most basic points. *Puffin* has the same slender wings that distinguish SUMPA.

Structure is extremely light. For example

(Continued on page 96)

Fun + Fishing
at CLUB
PEACE & PLENTY
GEORGE TOWN / EXUMA / BAHAMAS

An intimate and sophisticated resort nestled by the side of a brilliant blue sea offering

★ Modern rooms, each with private balcony overlooking the Harbour.
★ Beautiful swimming pool in a tropical setting.
★ Outstanding fishing, skindiving.
★ Beautiful beaches, sight-seeing.
★ Hard-surface 3000-ft. airstrip, 80 and 100 octane aviation gas.

UNICOM—122.8 MCS.
Manager: Bill Thomson, AOPA #142634
See your travel agent or write

CLUB PEACE & PLENTY
GEORGE TOWN
EXUMA
BAHAMAS

Learn to Fly

AMERICAN FLYERS
INCORPORATED

ARDMORE OKLAHOMA BASE / *The Worlds Largest and Most Respected Flight Training School*

For years, American Flyers specialized in the advanced training, only, of both airline and other professional pilots. This training, given at the Meacham Field base in Fort Worth, Texas, continues.
World wide demand, however, by students who wanted to *learn to fly* where the experts trained, brought about the establishment of a second base for American Flyers. This base, located at Ardmore, Oklahoma, is the world's most complete center for the training of pilots—both primary and advanced. Offering the greatest bargain of all in flight training, student pilots at Ardmore have the advantage of:

ASK ABOUT OUR CORRESPONDENCE COURSES

- Complete training, living and recreational facilities located on one airbase
- All basic fixed wing courses plus Rotorcraft Rating
- Flight Engineer Ratings—given on the American Flyers Airline Constellations
- Large variety of aircraft including NEW Cessnas, new Pipers, and new helicopters plus large multi engine planes for ratings
- Expert instruction with close personal attention
- Low density air traffic with no waiting for take offs and landings
- Newly furnished rooms and all meals for only 29.55 weekly
- Free recreational facilities including swimming, movies, sports
- Accelerated training saving both your time and money
- No Waiting — Classes starting every Monday
- Free placement service of graduates

MAIL THIS COUPON TODAY

REED PIGMAN, AMERICAN FLYERS Dept. 5
Meacham Field, Fort Worth 6, Texas

Please send me FREE booklet and data on courses checked.

☐ COMMERCIAL
☐ INSTRUMENT
☐ FLIGHT INSTRUCTOR
☐ MULTI ENGINE
☐ ROTORCRAFT
☐ FLIGHT ENGINEER
☐ AIRLINE TRANSPORT
☐ TYPE RATINGS
☐ COMPANY PILOT REFRESHER
☐ INSTRUMENT GROUND SCHOOL CORRESPONDENCE
☐ COMMERCIAL GROUND SCHOOL CORRESPONDENCE

NAME _____
ADDRESS _____
CITY _____ STATE _____
☐ VETERAN ☐ CIVILIAN
AGE _____ HOURS LOGGED _____

"THE AIRLINE PILOTS TRAINING SCHOOL"

AMERICAN FLYERS
INCORPORATED

WRITE OR CALL TODAY FOR ADDITIONAL INFORMATION
FORT WORTH, TEXAS—MA 4-7258 • ARDMORE, OKLA.—CA 3-4020

Within YOUR grasp!

Exciting opportunities in today's Aerospace Industry... Pre-Technical Preparation opens the door to *all* high school *graduates*. FREE booklet on Space Age Careers tells you how.

AEROSPACE DESIGN
AEROSPACE ELECTRONICS
AEROSPACE MAINTENANCE
***ENROLL NOW* for**
SEPTEMBER CLASSES
DAY & EVENING SCHEDULES
MONTHLY TUITION PLANS

ACADEMY of AERONAUTICS
LA GUARDIA AIRPORT
FLUSHING 71, NEW YORK · HA 9-6600

Send me FREE booklet on Space Age Careers

Name_____
Address_____
City_____ Zone_____
State_____ 71

WANTED YOUR CLEAN SINGLE OR TWIN ENGINE AIRPLANE
Write, Wire or Phone Details
GRAUBART AVIATION, INC.
VALPARAISO, IND. Ph. (219) 462-4105

AIRLINE OPERATION—DISPATCHER TRAINING
FAA approved Operation/Dispatcher Training Program for flight dispatchers, station managers, operations representatives and aircraft scheduling personnel. Also FAA approved Pilot Training Program for private, commercial & instrument rating. Call or write:
AIRLINE OPERATIONS TRAINING, INC.
AT INTERNATIONAL AIRPORT
Belt Pkwy. & Rockaway Blvd., Jamaica 34, N.Y., FI 1-2600

(Continued from page 95)

the fuselage (less pilot structure, wheels etc.) weighs less than nine pounds, and the tailplane (less elevators) less than five pounds. Full net weight is 118 pounds. Materials used in construction are balsa and spruce, with magnesium for the pilot's and transmission support structure.

De Havilland may not officially be in charge of the *Puffin* program, but their association with it has undoubtedly led to the support other industries have given. Dunlop designed, developed and donated the complete transmission system, gearboxes, wheels and special tires. Imperial Chemical Industries donated and gave technical advice on a special lightweight nylon sheeting that covers the complete airplane. Balsa was specially graded and supplied free. And amid a long list of other industrial participants is the U.K. Atomic Energy Authority for advice on the dispersion of static electricity.

Puffin's flight development is proceeding with more secrecy than many a military program I have known. First flights were by test pilot J.H. Phillips of de Havilland Aircraft, later ones by test pilot J.L. Barnes of de Havilland Engines. Finally in February 1962 came John Wimpenny, Assistant Chief Designer of de Havilland Aircraft.

The important point about John Wimpenny is that he is not a pilot. If experienced pilots found difficulty controlling man-powered types, you would expect non-pilots to find it impossible. Yet, probably because of difference in response and type of controls, pilots start with few advantages. Soon Wimpenny was flying *Puffin* as easily as anyone.

He flew 993 yards on 2 May 1962.

Rumors have since then been rife that a small engine was installed on *Puffin* to allow the pilot to take his mind off power-production and concentrate on turning. The trials were successfully completed and the pilot is now said to be practicing without the use of the engine.

I heard the view expressed by a member of one of the teams that the Kremer prize will not be won for at least another year. Though I do not personally agree with this, it would certainly be advantageous to the entrants of the third man-powered airplane on the list—the machine from Southend (not to be confused with Southampton). This is a two-place design by a group headed by Andrew Drescher. It is only now reaching completion.

Southend's machine employs constructional techniques similar to the other two but features a balsa propeller of tractor type mounted on a pylon above the cockpit. The crew of two sit side-by-side in a reclining position supported by seats set in an aluminum alloy frame. The wing is larger than both SUMPA's and *Puffin's* but has a section nearly the same as the former. And each wing has three six-foot ailerons so that any difficulty in turning can be ironed out by experimenting with a combination of these.

Andrew Drescher is quietly confident that he will have all the power he needs. The airplane is expected to weigh only marginally more than the others, 140 pounds empty, yet will have about double the power. Pilot will be Barry Stracy, a Britannia first officer with British United Airways. Crew will be Carl Barton, the champion cyclist. This airplane has a good chance of winning the Kremer prize, but even if it fails, it will still be the first man-powered two-place machine in the world.

This is the line-up in the man-powered contest. But the triangular race is only starting and the full story cannot be told until it is won. ✚

Riley Rocket

(Continued from page 35)

begins at a maneuvering speed of 210 mph indicated airspeed (IAS), and continues to a redline airspeed of 250 mph. Our Rocket stabilized to indicate 222 mph.

At the existing outside air temperature, this gave a true airspeed of 244 mph. This is certainly fast for a light twin, but had the air been rough, we would have had to slow to less than the 210 mph IAS maneuvering speed, which would have cut the true down to 231 mph. And therein is the Rocket's biggest dilemma. At low altitude, it is almost too fast for its own good, and Strayer says, "You've got to have a professional approach when it comes to flying this airplane in rough air." The day of our flight was a smooth one, however, and the number of occasions that demand the Rocket be slowed to its maneuvering speed will depend upon the number of rough-air days over the terrain that it crosses. It takes a little getting used to before a new Rocket pilot will feel comfortable as he cruises with the airspeed needle deep in that yellow arc. To avoid it, one must cruise at altitudes near 10,000 feet, where the indicated airspeed is below the maneuvering speed.

At 9,000 feet and 65 per cent power, our Rocket indicated 209 mph for a true of 240. At this altitude we pulled the throttles to idle, lifted the nose up and began to bleed off 120 excess knots to feel out the stall characteristics of the airplane. The airfoil nacelles are advertised to improve the lateral stability of the aircraft at low speeds as well as to give it a stall speed some five mph less than the original airframe. With landing gear and flaps retracted, the Rocket began to shudder at 82 mph, and buffeted violently down to about 70 mph, when the nose could no longer be held up and shuddered down through the horizon. The buffet was so positive in the stalls that accurate airspeed readings were not possible; we could only average out the blurred indicator needle and hope we were somewhere near a realistic stalling speed. With gear and flaps down, power off, the Rocket gave the same bone-jarring warning and stalled as the airspeed indicator jounced between 65 and 70 mph.

With the right propeller feathered, gear and full flap lowered, METO power on the left engine, the Rocket finally turned right against full left rudder at a minimum control airspeed (Vmc) of 83 mph. With 15 degrees flap, the Vmc was 64 mph. In single-engine cruise, Riley claims a 180-mph TAS for the airplane and a single-engine ceiling of 15,000 feet.

Cranking the right engine back into life, we stabilized at 65 per cent power at 7,000 and later at 5,000 feet, and found cruise