A PS EXTRA

HOW I BUILT THE Flying Cart

By Hubert Luckett

YOU'RE almost ready to believe in flying carpets when you open the throttle and see a 200-lb. load float eerily off the ground. Tip the handles slightly and you have to brace yourself to keep this wheel-less Flying Cart from skittering down the drive faster than you want

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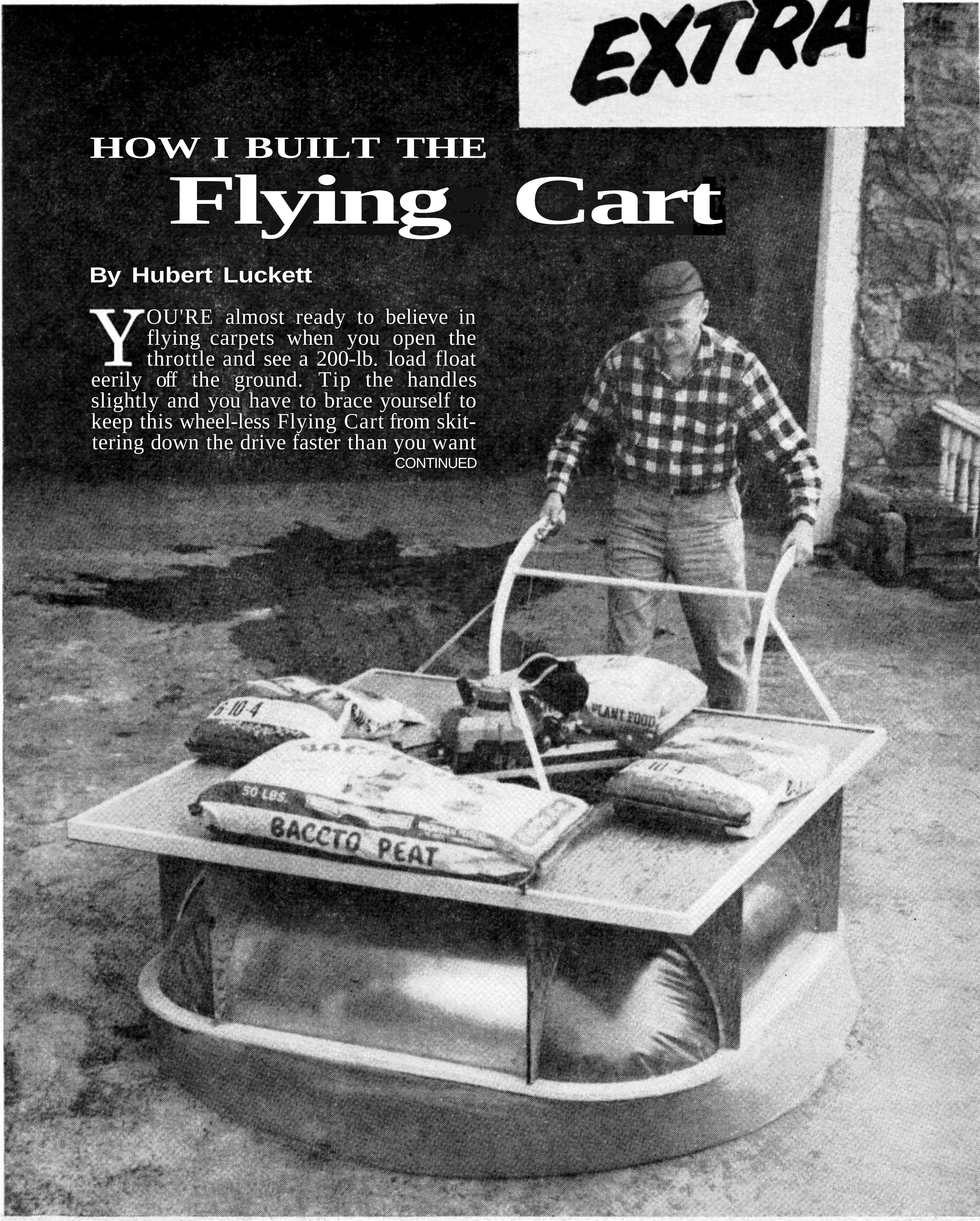
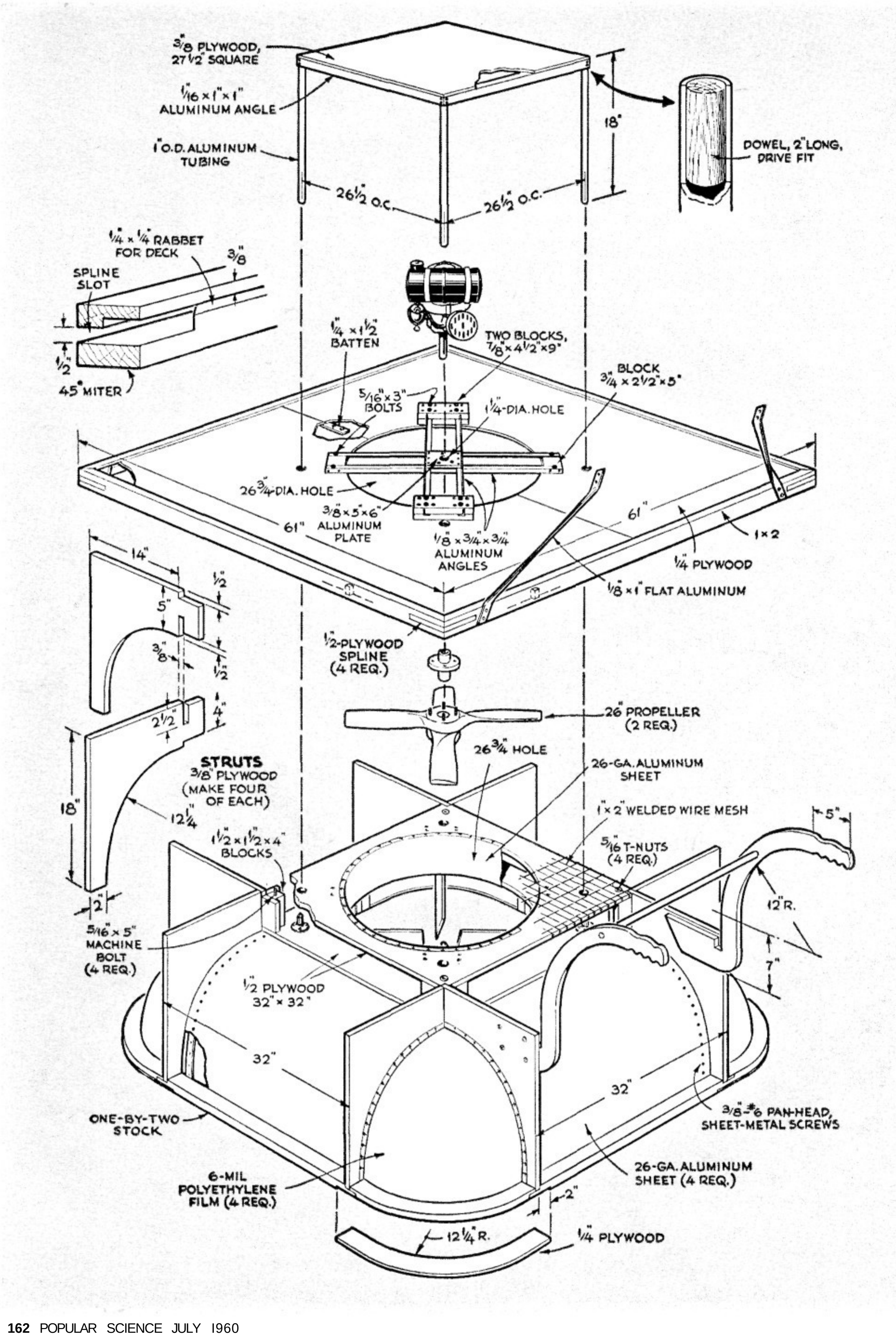
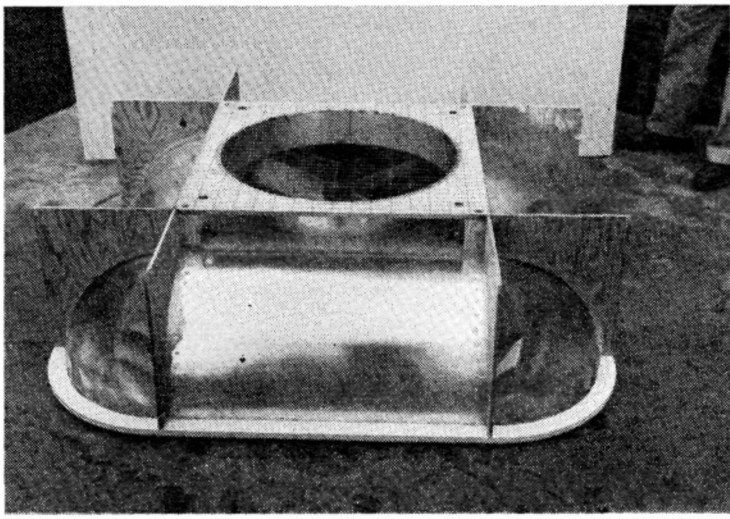


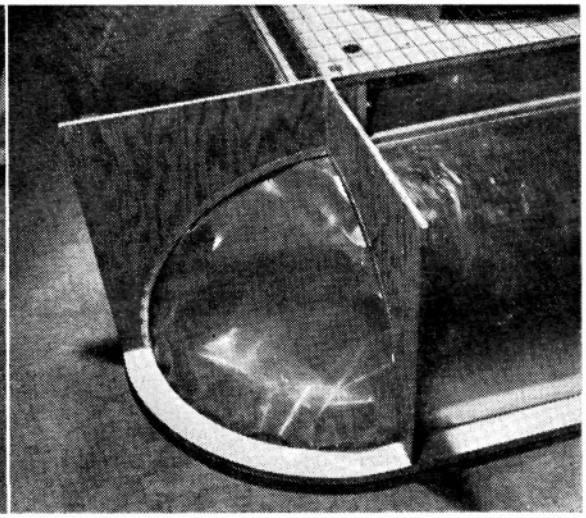
That's a 200-lb. load — four 504b. bags — entirely supported on a cushion of air.



3/8 PLYWOOD, 27 1/2" SQUARE
1/16 x 1" x 1" ALUMINUM ANGLE
1" O.D. ALUMINUM TUBING
26 1/2 O.C.
26 1/2 O.C.
18"
DOWEL, 2" LONG, DRIVE FIT
1/4 x 1/4 RABBET FOR DECK
3/8
SPLINE SLOT
1/2"
45° MITER
1/4" x 1 1/2" BATTEN
TWO BLOCKS, 7/8" x 4 1/2" x 9"
BLOCK 3/4 x 2 1/2" x 5"
5/16" x 3" BOLTS
1 1/4-DIA. HOLE
26 3/4-DIA. HOLE
3/8" x 5" x 6" ALUMINUM PLATE
1/8" x 3/4 x 3/4 ALUMINUM ANGLES
61"
61"
1 x 2
1/4" PLYWOOD
1/8" x 1" FLAT ALUMINUM
14"
1/2
5"
3/8"
1/2
4"
2 1/2"
1/2-PLYWOOD SPLINE (4 REQ.)
26" PROPELLER (2 REQ.)
26 3/4" HOLE
STRUTS 3/8" PLYWOOD (MAKE FOUR OF EACH)
18"
12 1/4"
2"
26-GA. ALUMINUM SHEET
1" x 2" WELDED WIRE MESH
5/16" T-NUTS (4 REQ.)
5"
12" R.
7"
1 1/2" x 1 1/2" x 4" BLOCKS
5/16" x 5" MACHINE BOLT (4 REQ.)
1/2 PLYWOOD 32" x 32"
32"
32"
3/8"-#6 PAN-HEAD, SHEET-METAL SCREWS
ONE-BY-TWO STOCK
26-GA. ALUMINUM SHEET (4 REQ.)
6-MIL POLYETHYLENE FILM (4 REQ.)
2"
12 1/4" R.
1/4" PLYWOOD

Plywood, plastic, and aluminum make the airframe





FINISHED "HULL" showing how fan shroud and rounded contours in the plenum chamber are obtained, using sawed-to-shape plywood covered with a skin of sheet aluminum and plastic film.

ALUMINUM IS FASTENED to inner curve of struts by bending a flange over flat against the plywood, and securing with stapling gun. Aluminum is slit every 1-1/2" to make a smooth bend.

to follow. More—you can easily trundle a 100-lb. load across a soft, soggy lawn with this machine and never leave a mark.

The Flying Cart is a true ground-effect machine (GEM). It has no wheels. It glides on a cushion of compressed air supplied by a modified chain-saw engine and a four-bladed wooden prop.

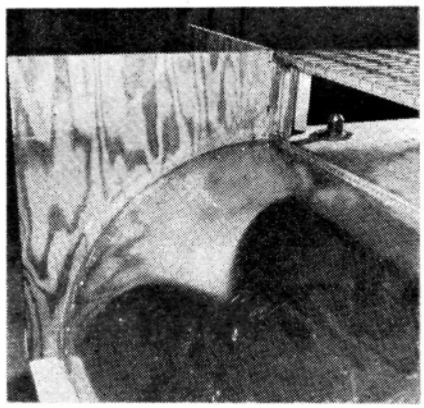
I built the "airframe" of ordinary lumberyard materials for $59.75. If you're well supplied with plywood scraps you can cut that figure in half. Engine and props are from an outboard air-drive unit sold by Airboats, Inc. (3323 N. Florissant Ave., St. Louis 7). New, they cost $130.

How it got that way. The cart didn't start out as a search for an improved wheelbarrow—it happened the other way around. The building itch came with the first story I read about air sleds, and intensified with each story thereafter. It was a challenge to build a totally new kind of vehicle before all the development problems were trampled to death—and all the unanswered questions were answered—by multimillion-dollar research programs.

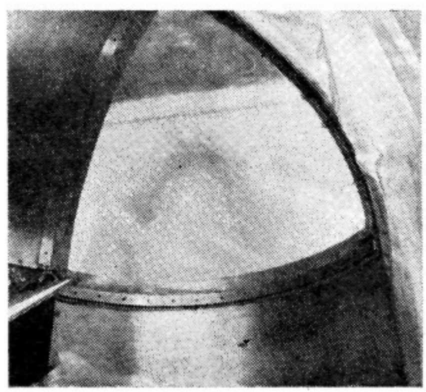
I doodled the requirements. It would have to be:

• Reasonably easy to build with ordinary home-workshop tools.

• Adaptable to continuing changes and experi-



CROSS-LAPPED STRUTS are clamped between main frames, glued and screwed to the spacer block. Note floor flange that anchors leg of the platform covering engine.



PLASTIC FILM is folded double under the clamps. Sheet-metal screws hold the two aluminum clamping strips. Plywood clamp at bottom is held by wood screws.

Write for fuller drawings

Want to build the Flying Cart? The drawing at left shows enough for you to proceed on your own. For larger scale drawings, send $1 to: FLYING CART, Popular Science, 355 Lexington Ave., New York 17, N. Y.

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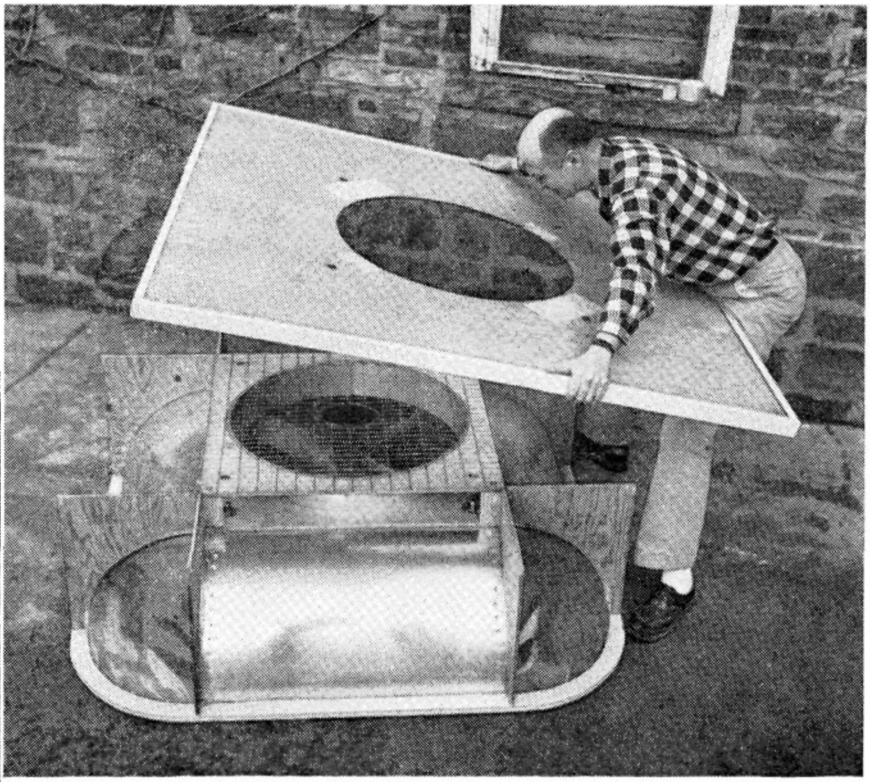
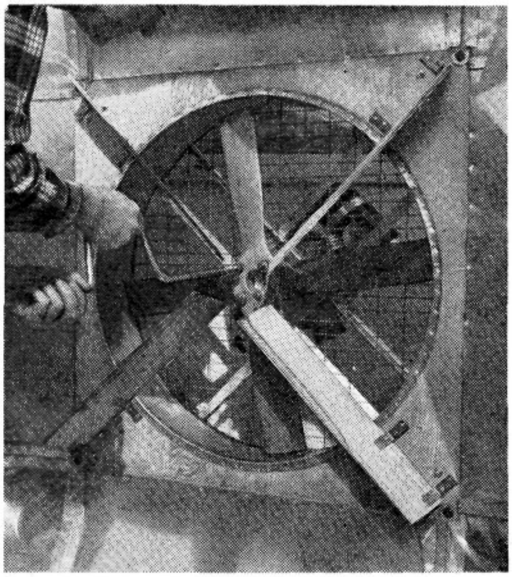
Add the deck, motor mount, and prop



DECK IS SEPARATE ASSEMBLY held by bolts securing the motor mount. Side rails are notched to engage upper corners of the struts and rabbeted to receive 1/4"-plywood deck cover. Wire-mesh blade guard is clamped between deck and hull.

MOTOR MOUNT is bolted through the deck and upper main frame. Hardwood blocks clamping ends of each pair of angles add rigidity to the mounting assembly.



PROPELLER MUST BE BOLTED to the hub after the engine is in place. Vanes were added after the first trials to counteract torque effect and improve the air flow.

mental modifications, yet functional in its most elementary form.

• Large enough to carry a practical load—not a toy.

• Small enough for one man to handle and not pose an awkward storage problem.

• Cheap enough for a modest budget.

All of these points apparently ruled out a riding vehicle. So when someone suggested an air barrow, it seemed like a happy choice.

The one that didn't work. Take one leftover sheet of plywood that happened to be 34" by 48"; nail one-by-fours to the edge to form an open box; cut a hole 24-1/2" in diameter in the center of the plywood sheet, and you have the body of my first "feasibility-study" model. A 1/2-hp. electric motor driving a 24", three-bladed cast-aluminum exhaust-fan prop supplied the air. I wanted to see if the crudest possible rig would provide any encouragement to go ahead with the project. It almost didn't. When I switched it on, the shop filled with a wild roar and a dense cloud of dust, but there were no signs of levitation. The air stream was hitting the floor and bouncing right back through the fan blades.

I extended the sides to 16" to get the fan farther from the floor. This time it teetered on the brink of floating. Backwash through the fan was greatly reduced. I rigged up a crude equal-arm balance and found that the machine required

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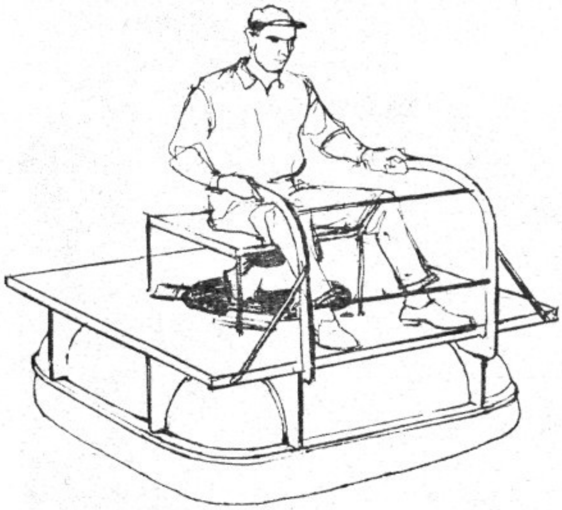
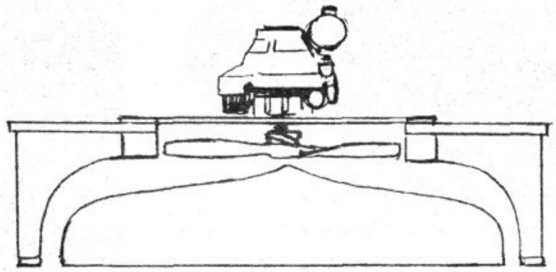
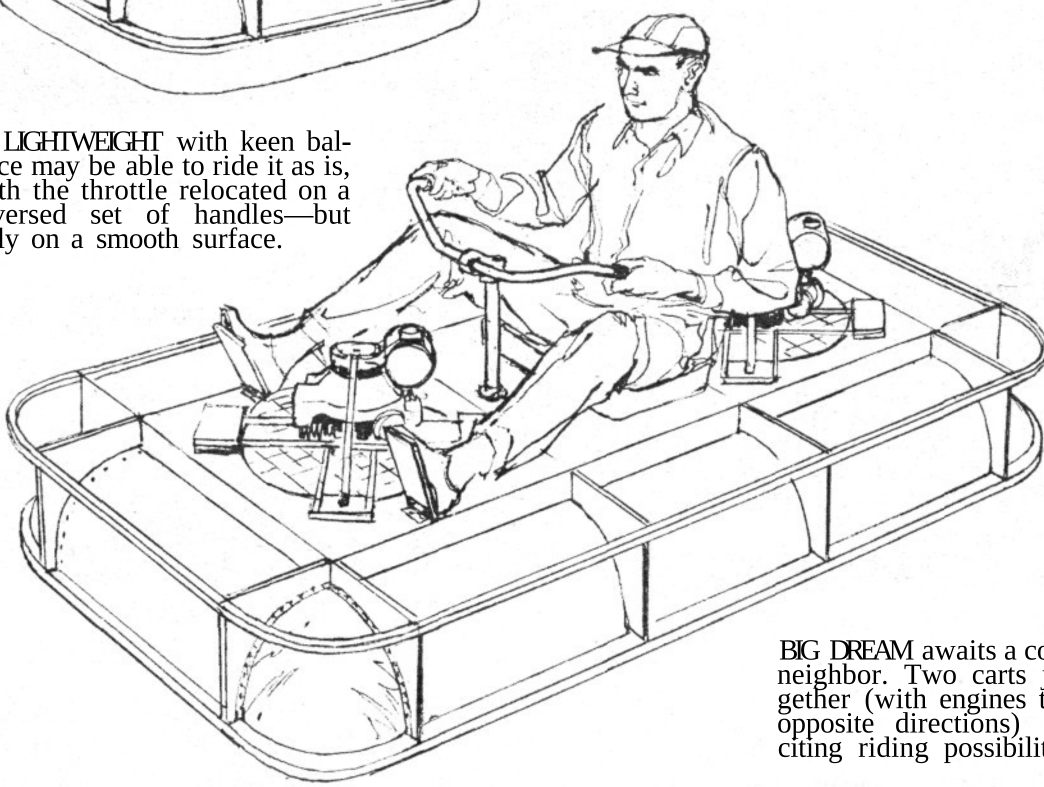
Author's sketchbook shows future plans



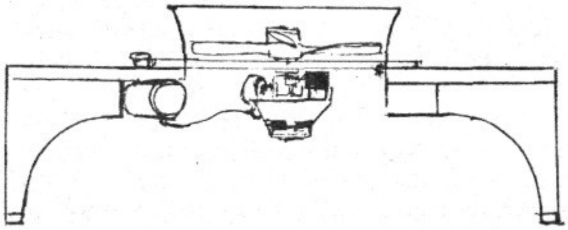


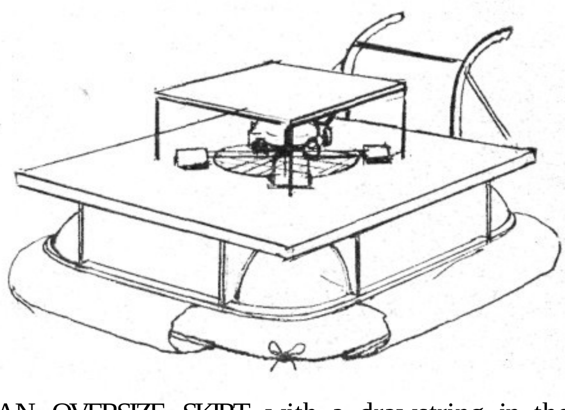
CONVERSION TO AN ANNULAR JET will be easy. According to theory, it should ride higher off the ground. Ill try a flat plywood bottom first, then tackle the problem of making a properly shaped core like this.

A LIGHTWEIGHT with keen balance may be able to ride it as is, with the throttle relocated on a reversed set of handles—but only on a smooth surface.



BIG DREAM awaits a cooperative neighbor. Two carts joined together (with engines turning in opposite directions) offers exciting riding possibilities.





INVERTING THE ENGINE would lower center of gravity and allow use of standard prop with an engine rotating in conventional direction.

AN OVERSIZE SKIRT with a drawstring in the bottom edge may improve stability and performance as an air barrow over rough terrain.

How I Built the Flying Cart

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68 pounds to balance with the motor not running—only four pounds when it was turned on.

Scarcely a resounding success. But in spite of air leaks, turbulence, fan inefficiency, and high weight-to-power ratio—I was getting 64 pounds of lift. It wasn't hard to think up reasons for going ahead.

The one that worked. Poring over all the research papers I could find, I came up with these rough specs:

• Shape—square. For a given area, power, and operating height, the shape with the shortest perimeter gives the most lift. A square is the closest practical approach to the optimum circular shape.

• Size—5' by 5'. The most significant factor in GEM performance is the "height-diameter" ratio (h/d). Within limits you can trade one for the other and carry the same load. A larger vehicle would operate higher off the ground, but it becomes clumsy to use and a problem to store.

• Design—plenum chamber. This is like an inverted saucer with the air cushion retained inside the bowl. It's the simplest of the proven GEM configurations, and gives good hovering efficiency close to the ground.

• Power—chain-saw engine. The tentative design promised to lift about 30 to 35 pounds per horsepower, as nearly as I could estimate. A reasonable payload would require five hp. The lightest five hp. I could think of was a chain-saw engine.

• Propeller— ??? This turned out to be a shopping problem. I was getting discouraged about finding one that would fit the shaft, blow the right way for engine rotation, and provide optimum load for the engine. But a half-dozen problems were solved at once when the Airboats unit was suggested to me. It uses a five-hp. Power Products chain-saw engine with reversed rotation and has a properly matched prop.

Building the air frame. Problem: How do you make a close-fitting duct for the fan and a smoothly contoured bowl for the plenum chamber with ordinary woodworking tools? Fiber-glass laminate would give the needed shapes, but would be complex to mold, and also would be too heavy in the required strength. A skilled tinsmith could do it with sheet alumi-

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num, using aircraft-type construction, but that was beyond me.

Plywood frames sawed to shape and covered with a skin of aluminum and plastic were the answer. The final design proved to be easy to build and turned out surprisingly strong and rigid for its weight. The completed machine, including the engine, weighs only 80 pounds.

Building the Flying Cart. First I cut out the two 32" squares of 1/2" plywood and the eight 3/8" plywood struts. I made a trial assembly of these parts, which form the backbone of the vehicle, using 5" bolts and TeeNuts to clamp it together. All other dimensions were taken directly from this framework. After all the wood framing members of the "hull" were nicely fitted, they were taken apart and reassembled, with waterproof glue and wood screws for all joints.

The sheet aluminum was fastened on next. The inner edge was screwed to the .1/2 "plywood first. The sheet was then pushed in tight against the inner curve of the struts and the bottom edge screwed to the one-by-two bottom frame. The 1/2" overhang at each end of the aluminum sheet was snipped every 1-1/2", the lip hammered flat against the strut and stapled with a stapling gun. The fan shroud went on next, with the top and bottom edges fastened in a similar fashion.

Enclosure of the plenum chamber was completed by clamping six-mil polyethylene across the corners, using the two l/8"-by-l" aluminum strips and the sawed-to-shape l/4"-plywood bottom piece.

The deck was assembled dry, placed in position and the notches for the struts marked. After the notches were cut, it was reassembled, with glue and screws.

First tryout. I didn't wait for such niceties as handles, throttle control, blade guard, and proper motor support, to see if it would work. With the major structure finished, I bolted a pair of angles directly to the frame to support the motor.

The engine took hold on the third pull of the starter rope. With a roar from the unmuffled exhaust and a cloud of dust from my driveway as it was swept clean by the air blast, the Flying Cart was first airborne at dusk one Sunday afternoon. It rose about three inches from the ground and hovered there. Startled faces popped up in neighboring windows and a horde of small fry materialized from nowhere. Cries of "What is it?" were soon replaced by, "Can I ride?"

I soon paid for my impatience. The motor support proved to be too limber and vibration broke the straps holding the gas tank.

Back in the shop, the motor support was stiffened by clamping the ends of the angles tightly between hardwood blocks and adding a second pair perpendicular to the first. Handles and flexible-cable throttle control came next.

Remembering the demand for rides, I made a removable platform to cover the engine. Supporting legs went through 1" holes in the deck and top main frame and were anchored with slip-in floor flanges screwed to the bottom main frame.

Early trials of the finished vehicle quickly led to the first two modifications. It would carry a load nicely on smooth pavement, but got into trouble on rough ground or going over a curb. A flexible skirt at the bottom caused the rigid part of the craft to ride high enough to clear obstacles. The skirt easily conforms to uneven surfaces and retains the air seal. This also eliminated most of the pushing in climbing hills. By holding the machine level on a slope, all the air escapes on the downhill side, thus providing thrust to push the cart uphill.

If you let go of the handles, reaction to the prop torque made the whole cart spin around. Vanes set in the air stream counteracted this, after a bit of fussing to get the correct pitch. An unexpected bonus resulted: The vanes seemed to smooth the air flow in the plenum chamber and gave a measurable improvement in lift.

The plastic corners are a considerable aid to the experimenter. With cloth ribbons stuck to various surfaces inside the chamber, a light shining through one corner •will let you observe air-flow patterns through the other three. Some curious things have shown up. Under certain operating conditions, part of the air flow seems to want to give a negative lift. It may actually be creating a suction that is limiting the operating height of the vehicle. Next step: modification of the air flow to eliminate this apparent negative lift. The machine may yet prove to be large enough to ride successfully.

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