Established 1936
SKY-SCRAPERS BKLYN NY
AMA Club Charter 470

FLYOFF

Round 28 / Winter 1994

The **SKYSCRAPERS** Quarterly

Edited by Bob Hatschek

What's up? XXVIII

Merry Christmas and A Happy New Year to All!

Oh come, all ye Skyscrapers, to...

...the annual dinner of all the Skyscrapers, on Saturday, March 11, 1995, at Manero's Steak House in Greenwich, Conn. We will have a private room and a cash bar. The party starts at 3:00 p.m., dinner at 5:00.

The menu offers your choice of filet mignon, chicken Florentine, or the fish of the day. Price will be $19.00 per person, including gratuities. You do not have to make an advance menu selection nor even pay in advance. But please call Bob Hatschek (718/224-3908) in advance to tell him how many places to set.

To get there, take I-95 (north or south) to Exit 3 (Arch St.) in Greenwich. Take Arch St. east for a short distance to Steamboat Rd. Turn right (south). Manero's is at 559 Steamboat Rd. (on left) one long block from Arch St. If lost, call us at Manero's (203/869-0049) for directions.

But report your 1994 scores first!

One feature of the banquet will be the annual awards: High-point trophies to the club's top three flyers; the Royal Order of the Purple Shaft to the Skyscraper with the worst luck in 1994—self-inflicted or not; and the trophy for the Outstanding Skyscraper of the Year. Nominations for these latter two awards may be made to Jean Pailet, who will pass your comments on to the "selection committee."

The point system was detailed in *FLYOFF 9*. All members who competed in any 1994 free-flight event should report their year's results to Jean Pailet (30 Emerson Rd, Brookville, NY 11545). Include date, name of meet and classification (A, AA, AAA, etc), event, your place, etc. Do it before Jan. 31, 1995.

Galeville Maintenance Fund, 11/15/94

	Amount	Balance
Previous Contributions		
Skyscrapers	2664.00	
Friends of the Skyscrapers	3939.00	
		6603. 00
Previous Expenditures	—5044.19	
		1558.81
New Contributions		
Skyscrapers		
		1558.81
Friends of the Skyscrapers		
Bill Fox (10/94)	15.00	
		1573.81
New Expenditures		
None (as of 11/15/94)		
Current Balance (11/15/94)		$1573.81

Sincere thanks to all donors. All contributions are welcome. Funds are held in a separate account and are fully reported here. Please send donations (payable to "Skyscrapers") directly to *FLYOFF*. Thank you!

The 1995 contest schedule

Jim Moseley phoned just before Halloween to notify *FLYOFF* readers that the 1995 Canadian FF Nats will be July 8-10 at Camp Borden, Ont. Indoor events will be in nearby Barrie. Most details are still pending, but keep posted by writing Jim at Apt 406, 2000 Sheppard Ave W, Downsview, Ont. M3N 1A2, Canada. Or phone him at 416/743-0145.

Early plans to hold the 1995 AMA Nats in Washington State July 8-16 had to be aborted (site availability problems, we understand). Instead, the FF Nats will be combined with the USOC at Muncie on June 26-30. And the FF World Championships in Hungary are set for July 22-28.

Galeville 1994 meet attendance was pretty slim, due mainly to schedule conflicts and uncooperative weather. We can't do much about the latter, but we're working on the former. And we would strongly appreciate YOUR comments right away on the events you'd most like to see at the Skyscraper Annual, scheduled for Aug. 26-27, 1995. Send them to *FLYOFF*.

The 1995 US Free-Flight Team

And just who is going to Hungary?

In F1A: Matt Gewain (Tehachapi, Calif), Skyscraper Andrew Barron (North Haven, Conn), Randy Weiler (Irvine, Calif). Alternate: Tom Coussens (Sylmar, Calif). F1B: Jerry Fitch (Sacramento, Calif), Louis Joyner (Birmingham, Ala), Dan Tracy (Maple Valley, Wash). Alternate: George Batiuk (San Luis Obispo, Calif). F1C: Gil Morris (Columbus, Ohio), Mike Achterberg (Sacramento, Calif), Roger Simpson (Leander, Texas). Alternate: Doug Joyce (Shandon, Calif).

This idea might help speed a return

Try this on your computer sometimes. It's quite probable that most people with personal computers of any variety will have some software (look in your word processing manual) that's designed to print mailing labels. And any place that carries any computer supplies will be glad to sell you self-stick mailing labels (like the one with your name on it on the front of this issue of *FLYOFF*) that will run through your computer printer. When you're planning to enter a meet at the AMA Muncie site, set up a label run with the following text:

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In Indiana, please return to
Academy of Model Aeronautics
5151 E. Memorial Dr., Muncie
or phone (317) 287-1256
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On my system, I type it once, "copy" it, and "paste" it as

[Continued on page 8]

Printed by Fletcher Printing Co. Fairlee, VT 05045

3rd Try + 1 for class A-B

By Clark Darling, The Skyscrapers

This airplane has evolved over the last four years through trial and error—hence the name. The first models of this design did not bunt. I experimented with right rudder for the last two seconds of engine run, which would kick the tail around, and enable the plane to transition into the glide mode. Some people told me that this doesn't work. But I was able to get the plane to perform fairly well except in high winds, when the transition became unpredictable. I have built many versions of this design from class A through class D. A, B, and C performed very well; D did not. I had trouble with the transition. In 1991, at the Magnificent Mountain Men's Championship in Denver, Ken Phair suggested some ideas for solving my problems. One was changing the stabilizer to a modified semi-symmetrical airfoil and increasing the wing incidence. The result was an airplane that did perform. At the '92 Nats, the model self-destructed in mid-air due to a timer malfunction.

My next move was to build one with a bunt function. I observed how bunting airplanes flew. I was leery of the rapid transition from vertical to horizontal flight. It seemed to me that if the launch was not perfect, or the plane was upset by the wind, this quick transition could end in disaster. So I tried to design one with what I call a "soft bunt"—less stab deflection for a longer time. So far it has worked fine. I have had some bad launches due to pilot error or wind gusts, but the bunt was gentle enough to keep the airplane out of trouble.

In the power setting the plane climbs vertically with no turn. It goes where you point it. The model has VIT, autorudder (right for glide), and a soft bunt (1-sec duration). The secret to this plane is that it must be made very light. I am presently using an old loop-scavenged OS 25 with an 8 x 5 prop and 35% nitro. The climb is impressive. A better engine would be a K&B 3.5 or 3.25 with an 8 x 4 prop.

Specifications:	Total weight	22 oz.
	Wing area	515 sq. in.
	Stab area	135 sq. in.
	Wing loading	6 oz. per sq. ft.
Stab Settings: (Approx)	Height of stab platform	3/8 in.
	Power to glide	+1/8 in.
	Power to bunt	-3/16 in.
Timer settings: (Approx)	Engine shutoff	As set
	Bunt	+1/2 sec
	Autorudder to glide	+0 sec
	Stab to glide setting	+2 sec

Construction— The fuselage is designed for strength with quick and easy construction. Because concrete landings are common at Galeville and most of my breaks occurred right behind the pylon, I developed a light, tapered, square fuselage made largely of 6-lb balsa (but with 10-lb stock right under the pylon) and 1/4" x .007" carbon fiber running the full length on the corners. To make application easy, the carbon fiber is on the outside. Glued with FlexZap, it holds very well. All my fuselages have two coats of quick-drying polyurethane varnish.

The pylon is built separately, using the diagonal rib pattern to obtain a symmetrical shape. It is built up from 1/16" sheet, with 1/8" ribs. To balance the model properly at 60%, the pylon is glued to the top of the fuselage only after all parts of the model are finished, covered, assembled, and shifted fore or aft. I have crashed this type of design several times and have never had a pylon break off.

The rudder is simply carved from 4-lb balsa into a 7% symmetrical curve and is reinforced with carbon fiber, which reinforces a stub that projects downward from the rudder through the fuselage and out the bottom, where it is sanded off flush. This allows good alignment and superior strength.

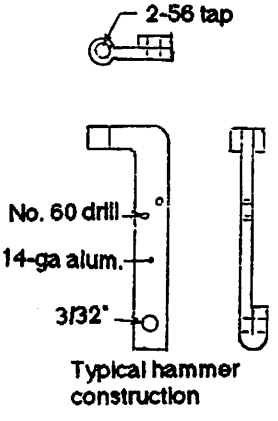
The Mylar-covered stabilizer, presently on the heavy side at 32 grams, would be better if it weighed 28 grams or less. Remember that for every gram at the tail, 5 grams are needed up front to balance it. The only way I have found to build very light and strong enough to avoid twisting deflections is to use Bill Dunlop's "Ex Cells" method (see *Model Aviation*, Oct, 1987). Stab section is a modified 8% Clark Y.

The wing, using a 9% St. Jean Ramrod airfoil with turbulator spars at 15 and 22%, weighs 240 grams and could be built down to 210 grams. The main spar is light balsa tapering from 1/2" x 3/16" at the center to 1/4" x 3/16" at the poly break. This is capped with 1/4" x .007" carbon fiber to the fifth rib, using Flex Zap. The two main panels are assembled with dihedral braces before the cap is installed. And wrap the dihedral break with Kevlar thread. Covering is light Micafilm.

Autosurfaces— The hammers are made of 14-gage aluminum. The bottom is folded up and a 3/32" hole is drilled. The top is rolled into an eye around a 1/16" mandrel and tapped for a 2-56 screw. (A 4-40 nylon screw would be a suitable alternate.) Spring and cable attachment points are drilled No. 60. To prevent the screws from digging into the stab, pieces of double-edged razor blades are glued where the screws bear.

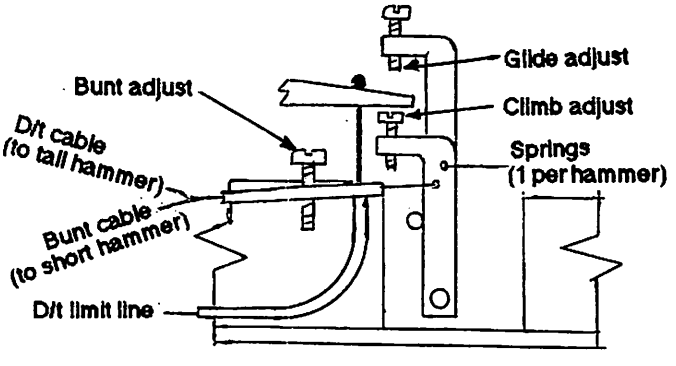
Both hammers are held forward by .008" steel cable and each is pulled rearward by a tension spring when its cable is released—the short hammer by the timer to actuate the bunt, and the long one by either the d/t function on the timer or by a fuse for d/t. The d/t limit line is 50-lb braided fishline connected to the appropriate timer trigger by a coil spring.

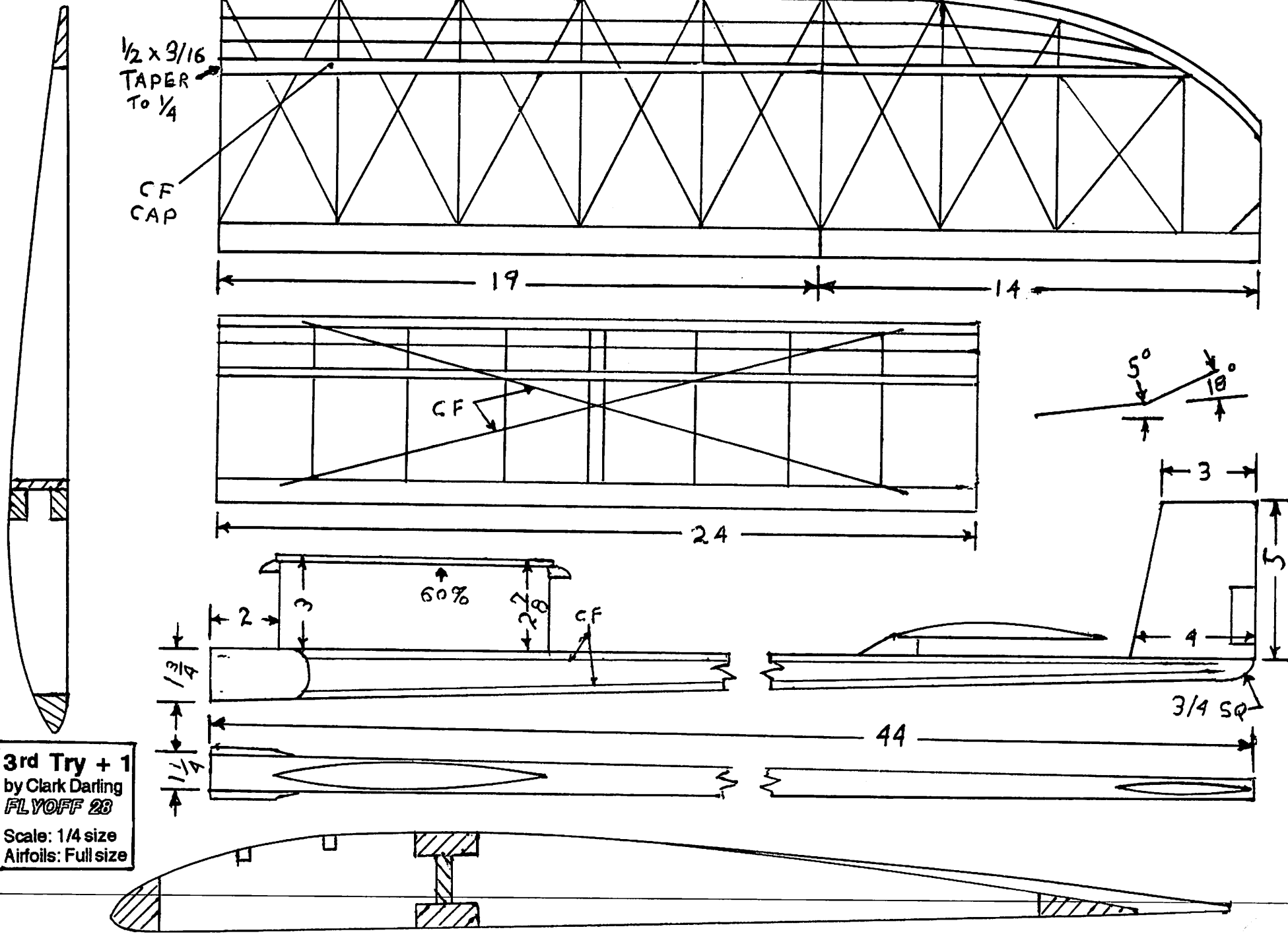
In operation, the first function is engine stop. Then, approximately 1/2 sec later, the bunt line is released and the short hammer is pulled back by its tension spring. This allows the spring on the d/t limit line to pull the stab TE down onto the bunt-adjusting screw head. The autorudder line (not shown in the drawing, but quite conventional) is released simultaneously. About 2 sec later the d/t limit line is released, allowing the stab TE to rise to the glide position. Finally, the cable retaining the taller hammer is released, its spring retracts it to clear the stab for d/t.



Typical hammer construction

If you have any questions about this model, contact me at: 33 Kentview Dr., R.D. # 10, Carmel, NY 10512.





3rd Try + 1
by Clark Darling
FLYOFF 28
Scale: 1/4 size
Airfoils: Full size

Introduction to CO_2

By Fritz Mueller

[Editor's Note: This outstanding article was prepared as a three-part series for *The Windy Sock*—newsletter of the Alamo Escadrille in San Antonio, edited by Joe Joseph. We found it in *The Thumbprint*, edited by David Mills for the Thermal Thumbers of Metropolitan Atlanta. It is reprinted here, with slight editing, in a single installment.—*FLYOFF*]

CO_2 is a power source strong enough for outdoors, yet it is quiet, non-pollutant and light enough to be suitable for indoors.

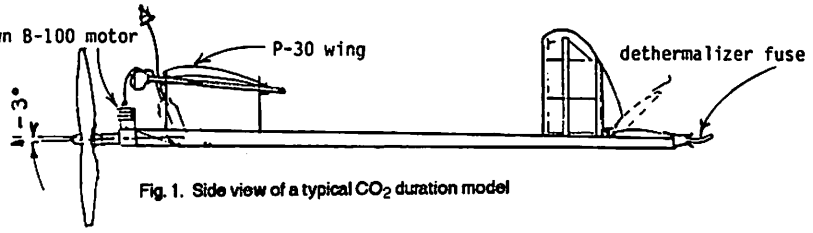


Fig. 1. Side view of a typical CO_2 duration model

To fully enjoy the advantages of CO_2 you must build light and precise models. The motor can be installed, handled and started with great ease, yet to reach reliability and perfection, there is no limit to the challenges of observing, identifying, interpreting and reacting intelligently to the peculiarities of this fascinating medium. Flying CO_2 will make you a better modeler and a bit of a scientist, too.



Fig. 2. A standard 12cc CO_2 capsule. Call them bulbs, cartridges, or 'Powerlets,' Crosman or Daisy, they are all alike

It is not advisable to put your first CO_2 unit in a scale model. The roots of FF are in duration—where the modeler's ingenuity can be fully dedicated to the technical aspects without compromise.

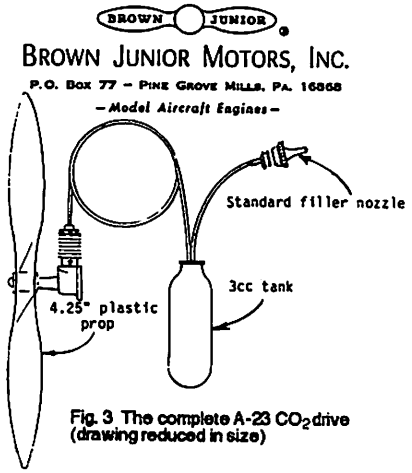


Fig. 3 The complete A-23 CO_2 drive (drawing reduced in size)

The Alamo Escadrille wisely decided to establish a new rubber power duration contest in September, for which the rules of the popular P-30 event were limited further to cut down on model chasing time. This new category is called P-24, indicative to the model's max span in inches. The permissible energy of 1/8" rubber 84" long (6.4 grams) swinging an 8" plastic prop makes this a sho-nuff hot machine.

It just so happened that the P-24 is royally suitable to be powered by the Brown A-23 CO_2 motor. The possibility exists to create a model which would convert from rubber to CO_2 in minutes. Equipped with a dethermalizer, this plane could then compete in any #163 AMA CO_2 event on the national level.

The best and fastest way to get the motor and the charger is to call Bill Brown's son David directly at 814/237-7504. (Expect a total of $89 on your VISA, which includes shipping.) The CO_2 capsules are those used in CO_2 pistols sold by K-Mart or other sporting goods stores. Brown's motors are not as easily damaged by beginner's mistakes, yet they are fully competitive with prettier products. The Brown charger will stand our hot climate better and will be applicable to all CO_2 engines, while some compatibility problems have been encountered with products made by others.

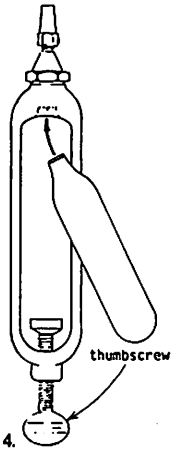


Fig. 4. Inserting the Powerlet

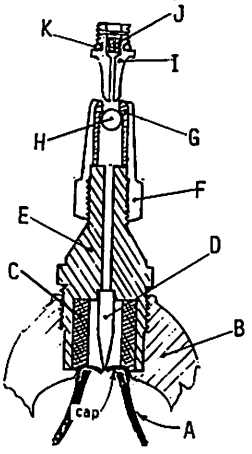


Fig. 5. Cross-section of the charger and filler nozzles

When fixing to use the charger for the first time, keep a basin filled with water and utility pliers handy to check leaks. Insert the CO_2 supply capsule into the charger as shown in Fig. 4 and start tightening the thumbscrew. What happens next can be seen in Fig. 5: The cap of the capsule (A) is pushed up against the steel needle (D) to be pierced, but no gas escapes at that time, because the conically ground needle tightly seats itself in the cap. By turning the thumbscrew further in, the cap will be pressed against the rubber grommet (C), which constitutes a second, but flexible seal. By slightly backing off on the thumbscrew, the needle valve opens and CO_2 passes through channels in the needle (not visible on the drawing) into the charger head (E). You can hear and feel when the steel ball (H) is propelled by pressure into the plastic check-valve seat (G).

Should you notice gas bubbles emerging under water between the charger body (B) and A, tighten the thumbscrew some more and slack off again. Bubbles between the charger nut (F) and E can be stopped by tightening F. In both cases, tighten just barely enough to stop the leak. The seals will be tight from there on. Slight initial leaks of the check-valve sometimes stop after a few seconds. Persistent bubbling of a new charger nozzle is improbable, but it can happen later by dirt lodged between H and G. Dirt particles, seldom big enough to be visible through a magnifying glass, are sometimes pressed into the plastic so hard that only the sharp edge of a properly shaped piece of hardwood can remove them. The remaining scars in the plastic seat will heal when kept in a warm place so that leaks will stop—maybe! Thus protecting the charger from dirt by storing it, for instance, in a plastic bag can save you lots of troubles.

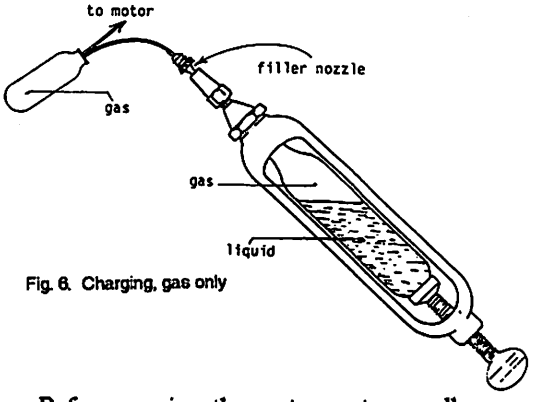


Fig. 6. Charging, gas only

Before running the motor, put a small amount of oil in the exhaust holes and on the prop shaft. For the first trial runs you may point your charger up at such an angle that the tank will be charged with gas only (see Fig. 6) About 80% of the CO_2 in a cartridge is liquid, the rest is gas. The charging process can be reckoned by looking at Fig. 5: the filler nozzle (I) is tapered; when pressed into the charger, its tip first unseats the ball (H) then the tapered part jams into the opening of G, which keeps further CO_2 from escaping. Pressure from the charger unseats the rubber slug (J) and CO_2 rushes into the tank. When the filler nozzle is popped out of the charger, pressure from the tank pushes the rubber slug (J) back into its seat, so that the pressure

remains in the tank. A small amount of oil on the O-ring K will prevent leaks.

Please don't let my seemingly too technical treatise spoil your appetite for CO_2 power. Get the equipment right now and you will see that making it work even without any previous experience is simpler than winding rubber. But a thorough knowledge about the subject will make you decisively more competitive.

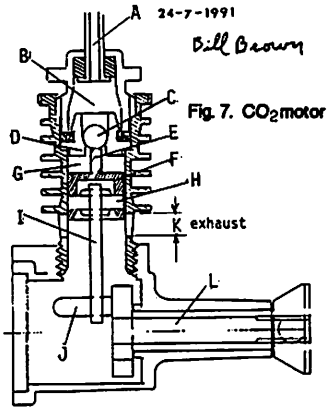


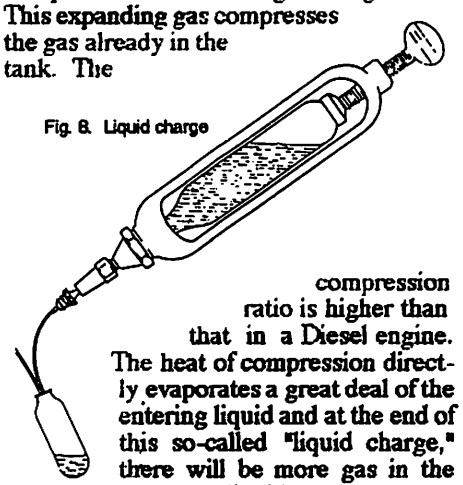
Fig. 7. CO_2 motor

Pressurized CO_2 gas enters the cylinder head B through the motor feed line A and pushes the ball C into the seat of the head-valve D. The valve-lifting pin E is a protrusion on the crown of the piston F. When slowly turning the crankshaft L you can feel the hard spot at which the valve lifter E contacts the ball. This position is shown in Fig. 7. The head-valve cracks open after the hard spot has been hurdled and gas pressure building up in the expansion chamber G pushes the piston down. Because the valve opens before the piston reaches the upper dead center, this initial thrust is tending to reverse rotation. But the torque produced near the peak position of the valve lifter is small and it gets even smaller when running because of the delayed pressure buildup in G. Thus, to start the motor, flick the prop over quickly and the breeze on your wrist will tell you that it is running in the right direction.

Past the upper center, the pressure of expanding gas acting on the piston is converted into torque by way of the wrist pin H, connecting rod I, and crank pin J. The remaining pressure near the lower dead center gets lost when the piston clears the exhaust ports K. Inertia makes the piston go up again past the upper dead center to repeat the cycle.

Before leaving the shop, Bill personally adjusts all motors to run at a moderate speed. The steel cylinder has a fine thread at the bottom, which is slotted and spread a bit to stay put by friction. When turning it counterclockwise (CCW), the cylinder and the head-valve will back off away from the peak position of the valve lifter (E). Thus the amount of admitted gas is reduced, because the ball (C) will be raised less and for a shorter period. By screwing the cylinder in CW, more gas is admitted, the motor will speed up, and the tank will empty faster. Get used to the idea that CO_2 motors are most efficient when running slow at or below half speed. The full speed range is within 3/4 of a turn. When flying a new model, start with just enough rpm for a long powered glide and then gradually work your way up to the desired speed.

The potential energy stored in a tank is proportional to the weight of the contained CO_2. A tank can hold more of it by weight when liquid, thus much more energy can be stored. When pointing the charger down, the CO_2 leaving the cartridge is liquid, but when released into a low pressure area it changes into gas. This expanding gas compresses the gas already in the tank. The compression ratio is higher than that in a Diesel engine. The heat of compression directly evaporates a great deal of the entering liquid and at the end of this so-called "liquid charge," there will be more gas in the tank than liquid.


Fig. 8. Liquid charge

To put in some more liquid, one could start the motor and run it at a high speed for a controlled period of time, aiming to frost the tank and still leave enough liquid in it to keep the pressure up. The charger should be kept pointing down ever since the first charge so that the cooler liquid stays at the charger nozzle while the other end of the bulb would warm up. At the second liquid charge the conditions are quite different: The tank is already pressurized, and the heat of compression is therefore minimal. The liquid in the cartridge is cooler because some of it evaporated to push out the first charge, but the pressure did not diminish too much because the round end of the bulb had a chance to warm up.

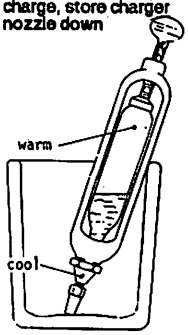


Fig. 9. Before a supercharge, store charger nozzle down

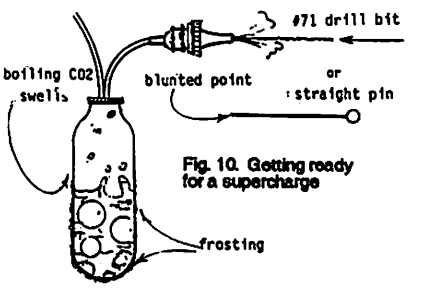
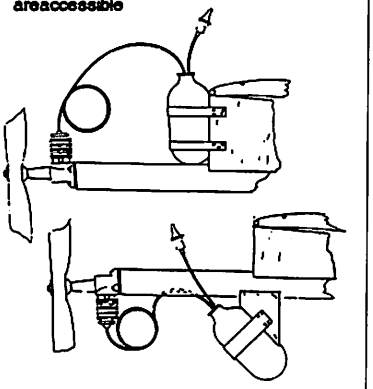


Fig. 10. Getting ready for a supercharge

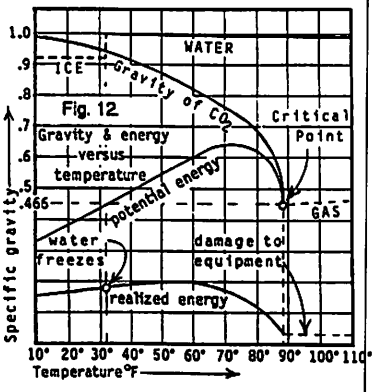
But to upset the speed adjustment and subject the motor to needless wear is not such a good idea. CO_2 gas can also be let out by inserting the smooth shank of a #71 (.0260") drill bit into the bore of the filler nozzle to unseat the rubber slug. When using a straight pin to do that, grind its point flat so it does not puncture the rubber. Select a tightly fitting pin which will limit the flow enough to keep the liquid from boiling over.

Fig. 11. Tanks on duration models areaccessible



Duration models have exposed tanks. When chilled with an ice cube while applying a liquid charge, they can be filled completely on the first try. Too much CO_2 in the tank will make the motor stutter; it will lose power or stall altogether. The liquid swells during evaporation; thus some of it could spill over a few seconds after a good start. To get a long flight, keep holding the ice cube against the tank until you start the motor, run the motor about 7 seconds beyond the last time it swallowed liquid and then launch the model.

CO_2 motors have been compared to steam engines. In fact, they are engines and they have a reciprocating piston driven by pressurized vapor. But that's where the similarity ends. Dry steam at 700 psi is so hot that it can char wood and cut through a 2 x 4 in no time, while liquid CO_2 has that pressure at 60°F! The higher the pressures, the more energy can be converted into torque and motion in a steam engine, but the efficacy of CO_2 engines begins to fall off at temps above 60°F in spite of the growing pressure.



The specific gravity of water at 40°F is 1 and it doesn't diminish much when warming up. In contrast, liquid CO_2 weighs as much as water when cold, but then expands to less than half of this density when reaching the critical temp.

Thus when cold, 1 gram of it fits into a 1cc space and already at the 60° station (see graph) a 1cc container will hold only 0.82g. This 18% loss in weight is made up abundantly by a concurrent increase in pressure, as indicated by the still rising energy line at that station. However, from 75° on the gravity and energy lines are dramatically dropping toward the critical temp of 87.8°F. From there on up, CO_2 ceases to exist in its liquid state regardless of the pressure applied on it.

"Realized energy" is the quantity of work performed at the shaft of the engine. This curve states that CO_2 engines perform best when filled and started at a liquid temperature between 45° and 55°F. When started at 70°, the gain in speed and power is upset by a higher consumption. CO_2 capsules have a fill factor of 0.8; the internal pressures will therefore be over 2000 psi at about 95°. Bill Brown's equipment will stand those pressures, some foreign products will not.

Soda Pop Gas. It produces a slightly sour tingling sensation, but beside that it is a tasteless, odorless, colorless, nontoxic, non-pollutant gas. Its chemical formula is CO_2 (carbon dioxide), denoting that one atom of carbon holds two atoms of oxygen in a chemical bond which can't be further oxidized, thus: O=C=O

Within a wide pressure and temperature range, CO_2 behaves like any other gas. The weight of the gas mixture on the bottom of which we live produces our atmospheric pressure of 14.7 pounds per square inch absolute (psia) at sea level. For us simple people, the barometric pressure at sea level is one bar. To double that, you have to compress the gas 2 to 1. Therefore a gage calibrated in bar gives you the ratio of compression, which, in turn, is the reciprocal of the gas volume (Boyle's Law).

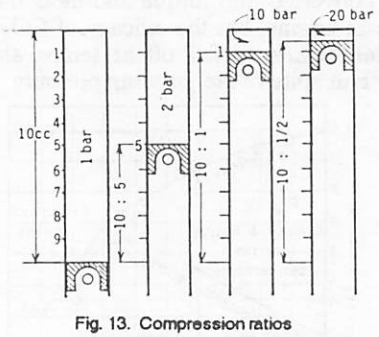


Fig. 13. Compression ratios

Ten cc compressed to 1cc produces a pressure of 10 bar. Thus a 1cc container holds 10cc of gas at 10 bar or 20cc at 20 bar. Conversely, 1 cc of gas at 10 bar expands to 10cc when released into the atmosphere.

As a gas is compressed, its temperature rises—because the total heat in the gas is now squeezed into a smaller space. The gas temperature will fall again by the same measure when the pressure is released. Thus we are talking about the "heat of compression" or "chill of expansion" even though no heat has been added or subtracted.

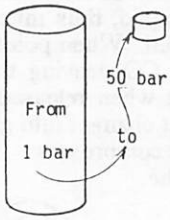


Fig. 14. Reduced volume at 50 bar (720 psi)

Liquid CO_2 has a pressure of close to 50 bar at room temp. In spite of the enormous compression ratio of 50 to 1, the harm done by compression heat during a liquid charge is not all that overwhelming because the original 3cc of air in the tank is a relatively small quantity, as can be judged from the small volume it occupies after compression.

The chill of expansion, however, is more bothersome. At temperatures over 75°F, the pressure differences at the headvalve are so high that parts of the gaseous CO_2 entering the expansion chamber collapse into minute particles of dry ice. Even if invisible, the calculated chill after decompression makes the presence of dry ice particles more than certain, which is confirmed by the drop in engine efficiency at these high pressures.

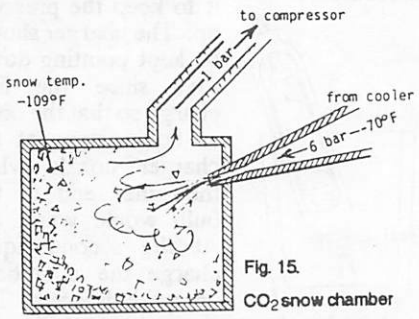


Fig. 15. CO_2 snow chamber

Solid CO_2 is commercially produced by expanding carbon dioxide in a snow chamber. The snow is then compressed into blocks and sold as dry ice. Notice that the temperature drop is about 39° at a pressure drop of "only" 6 bar. In the open (at 1 bar), dry ice maintains its low temp of –109°F by gradually subliming from its solid state into the gaseous state without becoming a liquid.

Two points are made: (1) A decompression from 55 bar to an average of maybe 20 bar in the expansion chamber of the engine will drop the gas temperature way below that of a snow chamber. (2) Once formed, dry ice will not readily evaporate and expand; it will blow out of the exhaust ports and with it some of the oil.

Water boils when reaching 212°F at the standard atmospheric pressure (1 bar). CO_2, however, must always be under pressure to stay liquid. Even just before turning into a solid it takes 5 bar (62 psi) at –70°F to prevent evaporation. This temperature may appear low to us, but there is plenty of heat in 1 cc of gas at that temp (maybe 3 cal) because, after all, –70°F is 390°F above the absolute zero on the Rankine scale.

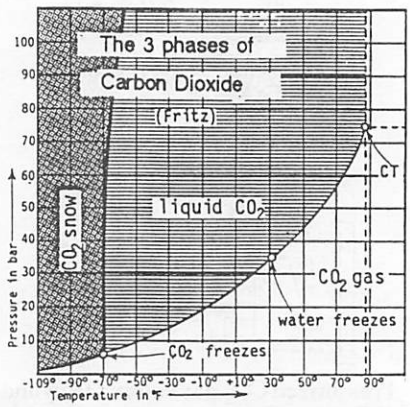


Fig. 16. Properties of carbon dioxide

The boiling temperature of any liquid depends on its pressure. The temperature-pressure curve of CO_2 in Fig. 16 shows that, beyond the critical temp (CT) of 87.8°F, carbon dioxide doesn't exist in liquid form. The pressure on the inside is 35 bar (500 psi) when the outside of the tank starts frosting up. Thus CO_2 engines can be operated in frosty weather. The initial pressure, for example, would be 420 psi at +20°F and, even if lowered to –20° by the subtractive heat needed to keep the liquid boiling, the final pressure would still be a respectable 205 psi.

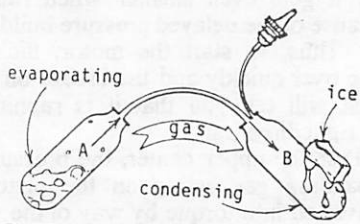


Fig. 17. Ice on tank B also cools tank A

Liquid CO_2 boils and absorbs heat when the pressure drops below the curved line in Fig. 16; gas condenses and gives off heat when the pressure rises above the line. The pressure throughout a closed system is identical in all locations. All portions of liquid CO_2 within a pressure system therefore have the same boiling (condensing) temperature regardless of where they are located. In Fig. 17 ice removes heat from the tank B so that gas condenses there. This lowers the gas pressure in the system and tank A uses its own heat to boil (evaporate) the liquid until its temperature drops to that of tank B. Thus the temp of all wet locations within a system equalize, but with a

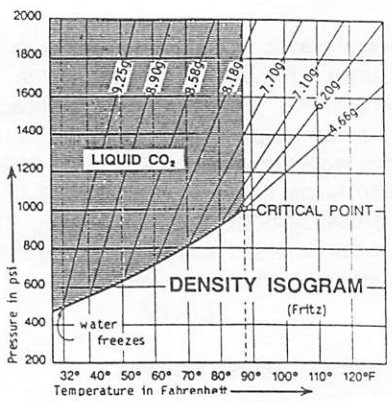


Fig. 18. Constant density lines are steep

slight delay caused by the somewhat lagging transfer of heat. Pressures equalize almost instantly because of the high pressure differences encountered. Any small temperature change produces a huge jump in pressure (10 psi per 1°F).

Fig 17 clearly demonstrates the possibility for CO_2 gas to condense into its liquid state at the cylinder head when the tank is still warm after a charge and the head is still cold from the previous run. The condensed liquid chills the engine further when seeking to evaporate.

Commercial cylinders for compressed gases are designed for a max of 2000 psi, hence the chart in Fig 18 tops out at that. The slightly bowed heavy line runs through the pressure-temp combinations at which CO_2 boils or liquefies (also see Fig 16). Ten cc of liquid CO_2 weighs 9.25 grams at 32°F. The liquid expands to the low density of 4.66g per 10cc at the critical point (Also see Fig 12). The pressure in a completely full tank will rise rapidly as the liquid expands at the slightest temp increase because liquids are not compressible. The first constant-density line at the left states that 9.25g of liquid in a 10cc tank will already reach 2000psi at 54°F. A 12g Powerlet has 12g of CO_2 in a volume of slightly above 15cc, equal to 8.18g per 10cc. The relevant density line on the graph reaches 2000psi at 92°F.

Skyscrapers Annual Fall Meet, 1994

Galeville, NY, Oct. 1-2, 1994—Dave Acton CD

F1A — A2 Towline (2 entries)

1	AndrewBarron	180	180	—	—	71	431
2	Kay Fags	111	165	—	—	—	276

F1B — Wakefield (3 entries)

1	Jim Brooks	180	171	180	180	109	820
2	Larry Pelatowski	83	105	145	180	151	724
3	Ed Pelatowski	—	—	138	180	109	427

F1C — FAI Power (3 entries)

1	Bob Gutai	180	180	180	180	—	720
2	Dennis Phillips	121	41	162	136	180	640

Nos Gas Combined (6 entries)

1	Dan Aggers	120	120	120	+92	452
2	BrooksGoodnow	115	120	2		238
3	Dennis Phillips	79	83	38		210
4	Justin Zeigenfuse (Jr)	120	—	—		120

P-30 Jr-Sr (3)

1	David Ellis (Jr)	120	64	78	262
2	Justin Zeigenfuse (Jr)	34	30	29	93
3	Chris Knapp (Jr)	23	20	27	70

P-30 Open (2)

1	Art Ellis	112	120	12	244
2	Bob Hatschek	75	120	—	195

PeeWee 30 (2)

1	Al Abriss	533	466	600	1599
2	Al Vollmer	386	368	631	1385

Dawn Mulvihill (4)

1	Bob Hatschek	224
2	L.Pelatowski	185
3	Art Phillips	159

1/2A Power (7)

1	Bob Geyer	102	120	120	342
2	John Carbone	120	106	113	339
3	Jean Pailet	106	90	120	316
4	L. Davidson	70	120	120	310
5	Dan Aggers	120	—	—	120

Hand-Launch Glider, Jr-Sr (4)

1	Peter Barron (Jr)	6	3	5	15	20	12	47
2	Chris Knapp (Jr)	10	6	9	25	4	6	44
3	John Barron (Jr)	4	3	10	6	20	11	41
4	Justin Zeigenfuse (Jr)	10	6	5	21	9	7	40

Hand-Launch Glider, Open (7)

1	Al Vollmer	80	65	25	50	—	—	195
2	Larry Pelatowski	51	30	22	3	3	58	139
3	Ed Pelatowski	37	26	39	44	34	49	132
4	Vic Nippert	33	21	14	33	35	40	108
5	Robert Zeigenfuse	27	29	26	33	24	14	89
6	Jean Pailet	21	18	28	18	20	23	72
7	Kay Fags	18	27	21	23	18	20	71

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[Continued from page 1]
many times as it takes to fill a sheet of labels (I get 36 to the sheet). Then stick one on each model near the nameplate.

In the past, at meets that last longer than a weekend, I've run labels asking the finder to call me at my motel during the appropriate dates and leave me a phone number to call back.

And at the 25th Annual Empire State Championships, sponsored by the Western New York Free Flight Society, every entry packet included such a label asking the finder to contact the CD locally. If you asked, you could get more labels. Thanks, that was a good idea, Brooks Goodnow, but my Mulvihill is still weathering in the woods.

Maybe more meet sponsors could provide this service.

From our readers

To the editor,

Enjoy your paper! By golly! I'm going to build your Goblin P-30. However, I can't find carbon fiber rod in my area. Do you have a mail-order source?

Pete Wilczek
Minnetonka, Minn.

Carbon fiber rod in a variety of useful sizes is available from:
Aerospace Composite Products
P.O.Box 16621, Irvine, CA 92714
(Phone 714/250-1107 or FAX 714/250-0307)

Also, Seattle reader Mark Sexton, who co-edits the Strato Bats' *Bat Sheet*, writes that he'd like to try a Delrin nose block, like the Goblin's, but he doesn't know where to get the Delrin.

Delrin is DuPont's acetal plastic. Others also make acetal. One other brand I have used is Polypenco. Ask for "Delrin," and you'll get some kind of acetal. (And once you machine it, you'll love it!) Various plastics supply houses carry it. You can mail order it (rods and flat stock) from: Small Parts Inc., 13980 NW 58 Ct., P.O. Box 4650, Miami Lakes, FL 33014-0650 (Tel: 305/557-8222 FAX: 1-800/423-9009). Get their catalog. They are especially good for small orders of screws (including nylon and metric) in sizes we modelers find useful, etc.

FLYOFF

1994 Skyscraper Monthly Meet Results

Oct 23, Rain, very light drift, Dave Acton, CD

HLG		Cat G		1/ 2A	
Vic Nippert	111	Al Vollmer	132	Jean Pailet	318
Al Vollmer	86	Vic Nippert	111	John Carbone	317
Andras Vig	68	Harvey Poirier	67	ABCD	
Harvey Poirier	57	**Moffett**		Dennis Phillips	360
J.Schlosberg (J)	33	Art Phillips	360	Clark Darling	120
		Ray Factor	312	P-30	
				Bob Hatschek	113
				J. Schlosberg (J)	7

Previous monthly meets were reported in *FLYOFF 26* and *27*. Total scores for all participants in the 1994 season will be reported in *Round 29*