Flapper Facts

Newsletter of the Ornithopter Modelers' Society
Summer 1997

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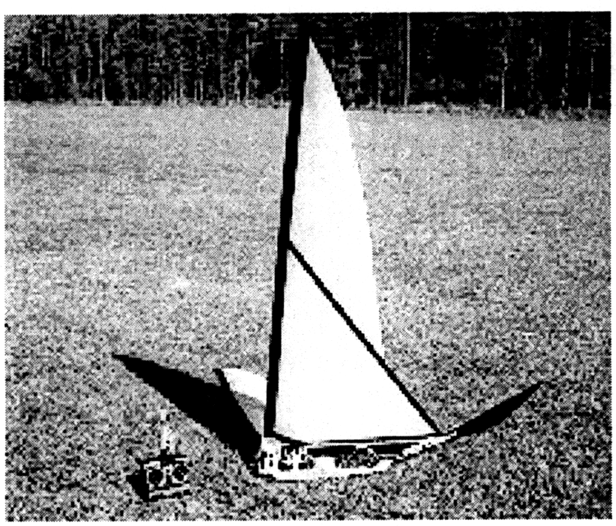
Sean Kinkade's Engine-Powered, Radio-Controled Ornithopter!

Sean Kinkade



Guest editor's note: On May 2, 1997, Sean Kinkade of Chuluota, Florida reported great success with an enormous membrane-winged ornithopter, under three-channel radio control. Sean began picking up where P. H. Spencer left

off, intending to build RC sport ornithopters. While the development of a fully-responsive control system remains a challenge, Sean's machine-- hoisting nearly four pounds AUW into the air-- is an astoundingly effective flyer, and a completely satisfying, debugged design will undoubtedly be forthcoming.

Sean writes: "Yes, the VT-1 really flies and the only thing preventing us from taking it into the upper atmosphere was a right turn tendency that would not respond to full left rudder input. Rhett [an acquaintance] flew it in low circles and brought it down gently onto its skid. We then tried to compensate for the turning tendency by having the radio gear hang off the left side. We flew it again and he took it up to tree top level but it still circled. We tried everything we could there in the field but couldn't solve the problem. The final flight was timed at 64 seconds and had to be cut short because the breeze blew the VT closer to the trees with each circle."

"I was very pleased with the flight characteristics. At launch, the bird looks like it needs a lot of power to get up to speed but once cruising you can cut back the power for some slow flaps without an abrupt loss in altitude. When Rhett decided he'd better bring her in, he lowered the throttle and the bird came in slowly for a perfect soft landing! We still don't know what will happen at dead stick from a high altitude but from what I've seen I don't think it will be disastrous. As it is, you can still fly the model safely like you would a helicopter. Just bring it in before you run out of fuel."

"The first flights of the day were not flights at all but powered descents. We were all shaking our heads until I had a last ditch hunch to try moving the CG back. It was like night and day. The VT flew. It was strange because this beast does not act like an airplane at all. When the CG was too far forward the nose could be held up by up elevator control but the bird acted like it didn't have enough thrust and it just came down. Once the CG was moved rearward it accelerated and climbed out. Now I have the CGmarked on this model."

"God bless P. H. Spencer and his simple wing design. This ends a 14 year chapter of my life to create a flying gas powered RC ornithopter. Let the new chapter of production models begin!"

Iron Curtain

Nathan Chronister

Recently I heard something about the Berlin Wall coming down. Is this true? Although I hear the Iron Curtain has met its end, one would not know it by looking at the OMS membership roster or by reading Flapper Facts.

Unfortunately, although there is a lot of ornithopter activity in Eastern Europe, we know very little about it. I've heard brief mention of several powered ornithopter projects and a few manned ornithopters in Russia, and I know there is a well-established aeromodeling community in other Eastern European countries. However, I never find any detailed info on the activities there, so I have no news to share.

The solution to this problem is simple. I need to contact model magazines and ornithopterists in Eastern Europe and Russia so I can find out what the heck is going on over there! But I need help from some of our European members. Do you know the address of any model magazines in Eastern Europe? Do you know the address of anyone there who is interested in ornithopters or who might know someone who is? If so, please send me these addresses. Then I will do all the work of tracking down whatever information I can find and reporting it to you!

The Ornithopter Modelers' Society has ended the days when individual ornithopterists had to work in isolation without knowing what else had been done in the field. With your help we can expand this success to include the entire planet.

ORNITHOPTERS

Imitating the Flight of Birds

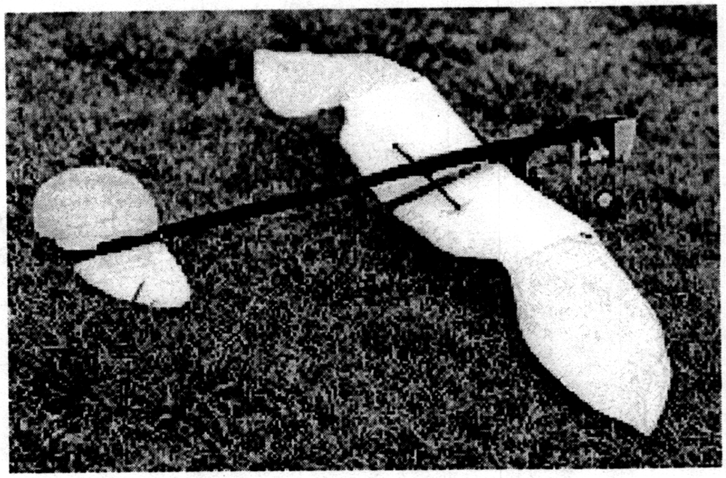
The OMS web site has a new look and some new information.

See it now at
www.earthlink.net/~pazuzu/orn.html

Web space provided by Patrick Deshaye.

A Phased-Span Ornithopter

Patrick Deshaye



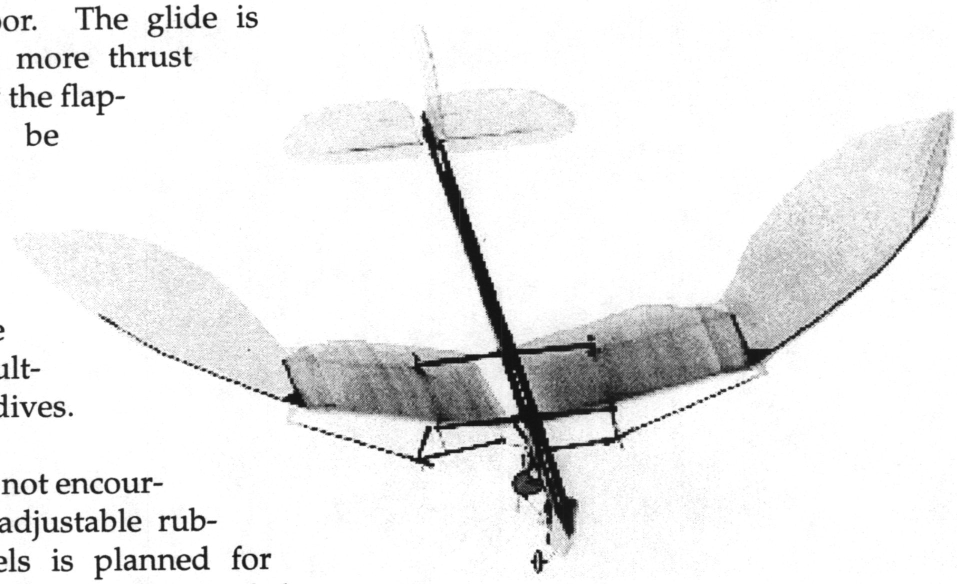
In a design concept submitted for Nathan's "Folding Wing" contest, the brilliant ornithopter pioneer John S. White suggested the use of a mechanism which would actuate the wingtips 90 degrees out-of-phase to the inboard wing surfaces (FF Spring 1995, entry "K"). This idea offers several attractive possibilities, not the least of which is the dampening of variable crank loads which have been the ruin of so many simple, monoplane ornithopters. Such an arrangement also offers the possibility of a much more naturalistic wing design, i.e. one more consistent with the structure of a real bird's wing, and exhibiting a more recognizably "bird-like" wing motion. Indeed, the possibility that the wing could be separated into built-up, inboard lifting sections and propulsive wingtips would seem to offer the potential to build heavier machines--insofar as the inboard, less vigorously-flapping wing portions could be counted upon to provide most of the support--without resorting to a fixed-wing/flapper propulsion subterfuge. For want of a better term, one might call this the "phased-span" concept.

In the mid-80s, Roger Schroeder had a similar idea, and built a testbed, but with poor results. The problem was the "canceling" effect of the motions of the inner and outer panels; such a device tends to do more "elbowing" up and down than effective flapping. One would hope to achieve the opposite, of course: why could the wing motions not be phased in such a way that they result in an aerodynamically or mechanically synergistic effect, analgous to the "cracking of a whip" along the span, rather than interfering with one another? Intuition persuaded me that by keeping the flapping amplitude of the inner panels to less than 1/3 that of the tips, an effective flapping "wave" could be propagated from root to tip. I set about to build such a machine for half-A power.

As shown in the accompanying photos, the design owes much to Alexander Lippisch (Zaic, 1938; Aeromodeller Annual, 1977). The inboard panels "teeter-totter" about a pivot point from which an idler arm hangs, which serves to synchronize the conrods to the wingtips; besides that, the mechanism is very similar to that outlined by White. The lifting panels are fabricated from polyethylene foam sheet over a steel wire/bamboo framework, and are quite light. The flapping action is very smooth and bird-like, with an undulating (whiplike) spanwise motion. Interestingly, with the crank rotation reversed, the flapping is not smooth at all!

Unfortunately, the project suffers from numerous problems. Much flapping power is lost in sagging and flutter along the span, and the power transmission in general is very poor. The glide is draggy, and much more thrust than is produced by the flapping tips would be required to sustain flight, despite the low (9 ounces) AUW. What few powered tests have been attempted resulted in rapid power-dives.

While this model is not encouraging, a series of adjustable rubber-powered models is planned for further experimentation. It is hoped that some "sweet spot" of spanwise phasing can be found which might provide some aerodynamic or mechanical advantage.



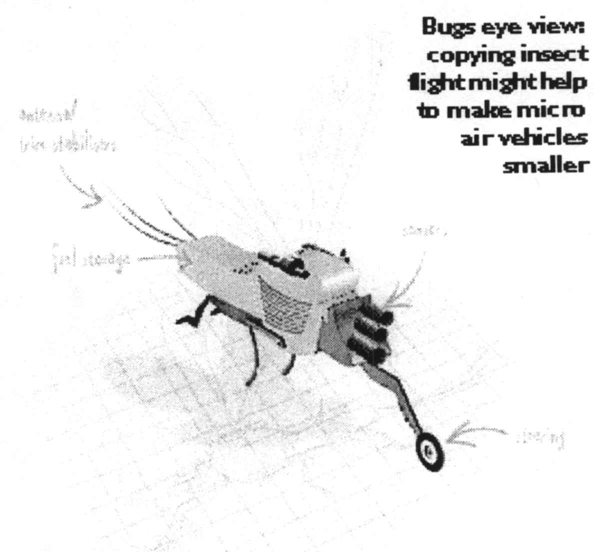
Phased-span experiment viewed from above. There are four conrods connected to the bellcrank; one to each inboard panel and a pair indirectly driving the wingtips.

Ornithopters on the Internet: the Fact, Fantasy and Future of Flapperdom

Patrick Deshaye

There can be little doubt that the internet has been a great boon to ornithopter afficianados. Several OMS members remain in constant contact through E mail, and the OMS web site has become a nexus for recruitment and distributing information to the public. Information on ornithopters, at least until the formation of OMS, could only be obtained from a few far-flung and obscure sources; many orni enthusiasts recall the drudgery of combing through library shelves and magazine stacks for a tiny article here or a passing reference there. Today, a glut of orni info is just a keyword away through any popular search engine on the World Wide Web.

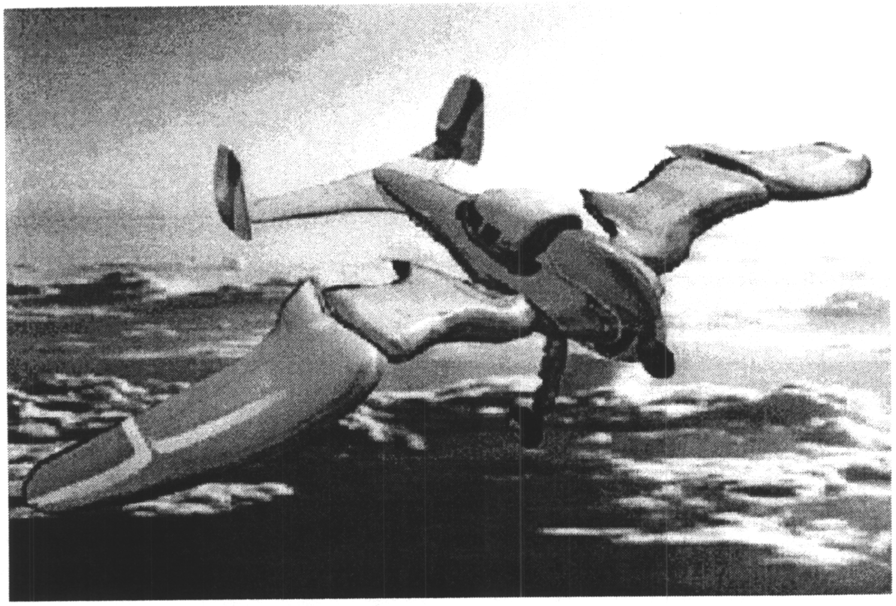
Unfortunately, not all of that ornithopter information is of interest to us; some guidance is needed, lest one find oneself wad-



The future of survey and reconnaissance? From *New Scientist* magazine's website.

ing through a morass of go-nowhere links. The first thing to watch out for is the preponderance of links to mystical or science fiction role-playing games, to which the search word "ornithopter" will lead you; perhaps half of the 450 or so links containing the word "ornithopter" are of this sort. These games apparently involve "cards" or "decks", and the "ornithopters" are often described as "artifact creatures". There is some connection here to the "Dune" (Frank Herbert) series of science fiction novels, in which flapping-wing aircraft powered by large, pulsating molluscs are found. One does well to configure one's search to avoid these links.

http://www.nsplus.com/ns/970405/features.html (The British _New Scientist_ magazine feature on "palmtop planes" or MAVs [see illustration], a very orni-friendly branch of aeronautical research.)



Designers at Toyota came up with this futuristic vision of a piloted orni.

A good portion of the links turned up by search engines lead back to the OMS web site. Many aeronautical and modeling sites have linked to us, and while that is flattering, it can become a bit tedious for those in search of something new.

Here is a synopsis of a few URLs of interesting, or at least intriguing, internet sites:

http://www.astro.su.se/~daniel/photo.html (Includes photos of bizarre ornithopter experiments by a merry band of Swedish modelers.)

http://www.robotgroup.org/projects/roboblimp.html; (The infamous robot orni-blimp by David Santos.)

http://www.toyota.co.jp/University/Symposium/Lobby/orni/index-e.html (The Toyota design team hallucinates futuristic ornithopters [see illustration]!)

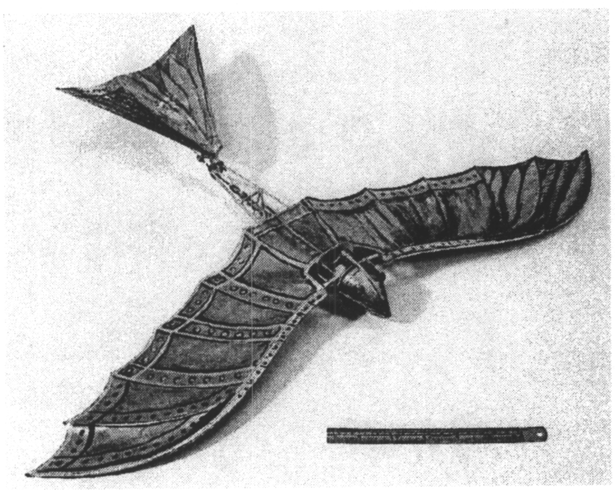
http://www.ae.msstate.edu/~agb/resume.html (George Bennet's resume, including citations of rather sophisticated ornithopter research.)

The foregoing is just a sample of the sort of pages which diligent internet searches can turn up. Please contact the OMS webmaster (pazuzu@earthlink.net) to report any exciting ornithopter-related sites you may find while websurfing... and have fun!

Freaky Bird

Nathan Chronister

James DeLaurier writes that his research group recently built some small electric-powered ornithopter models for a movie based on a popular kid's book called "Freak the Mighty." These models do not fly, but based on movie magic, they will look like they do. DeLaurier wanted to make flying models (like the movie Birdie, which featured an ornithopter by Ken Johnson), but the director wasn't interested. "Later, when I saw the filming, I understood the need for movie prop robustness," DeLaurier says, "these had to crash into a tree again and again."



Despite the non-flying nature of the models, much was learned about small motors and geartrains that might be applied to a flying model. The photograph shows an apparently rubber-powered model, also made for the movie. A 15 cm (6 inch) ruler provides scale.

Guest Editor's Note:

The final pages of this issue of Flapper Facts reprint an item from the 1978 Aeromodeller Annual. For several years, the publishers of Aeromodeller have been most generous in granting permission for us to reprint items from their interesting, adventurous magazine. We encourage our readers to subscribe to Aeromodeller:

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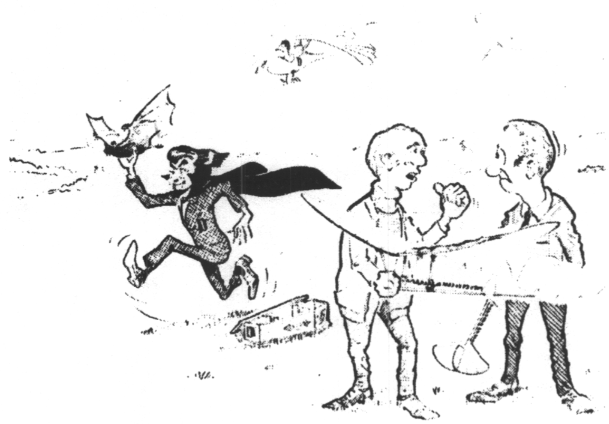


"That new member's walking away with the ornithopter event."

John Drake (left) assisted by Roy Sturman of Autogyro fame. The wing is beating at three beats to the second!! Exposure 1/25 second. Blurred wing illustrates the high flapping rate. There is no need to hold fuselage, the characteristic St. Vitus' Dance of most ornithopters has been overcome by articulating the wing.

AN EXPERIMENTAL R/C ORNITHOPTER

by John Drake

THIS MODEL is a direct result of the competition promoted in the December 1972 issue of *Aeromodeller*. It is the latest in a series varying from small rubber driven and CO_2-operated models to a large 10 cc powered 8 ft. span. All had the same articulated wing movement, the main variation being in the design of the mechanism and structure of the wings.

The success rate of these models was very low, by which is meant only one rubber-powered model flew out of at least six models! The non-flying attempts, nevertheless, were all very educational in the sense that they taught as much about what *couldn't* be done, as *could*!

For instance, early mechanisms were all buried within the wings, which made them difficult to construct, and the mechanisms were generally not stiff enough *i.e.* the shafts used for actuating the outer wing tips deflected and twisted when under load. Also, bearings seized up. All this resulted in undesirable wing movements. That is why the latest wing is operated by external cables.

One of the early lessons learned was that it is most difficult, if not impossible, to launch an ornithopter from rest by wing movements alone.

This can be said with a certain degree of confidence, because large birds, like swans, have great difficulty in getting airborne. As many will have noticed, swans have to paddle their feet to assist their wings, and generally have to make a supreme physical effort, using all possible leg and wing movements to get up to flying speed. Once up to flying speed, and a foot or so above the water, they are then able to use the full stroke and power of their wings to climb away from the water.

This was considered at some length, even to the extent of providing a drive to the undercarriage wheels, and retracting a very long legged undercarriage. The long undercarriage would be necessary to lift the wings clear of the ground, when the wings are at the bottom of their stroke. Problems in this area, are mind boggling, and with the added difficulties associated with the wing movement, it was essential to think of something far less complicated.

After much searching, a propeller was used to get the model airborne. Using a propeller has the advantage of allowing the undercarriage to be kept short, and hence there will be no need for a retract system.

As the model is purely a research vehicle to find out what wing movements are necessary to produce thrust and lift while airborne, use of a propeller would not be cheating too much. In any case a way of stopping the propeller was devised and the drive transferred to the wings whilst in flight, using the fourth servo of a 4 function radio control unit. In this way any spectators could be convinced, that if the machine continued to remain airborne, the flapping wings *must* be producing a modicum of thrust.

A final feature of the wing flapping mechanism was to devise a means of returning the wing to the glide position, which only occurs at one point in the complete wing-beat cycle.

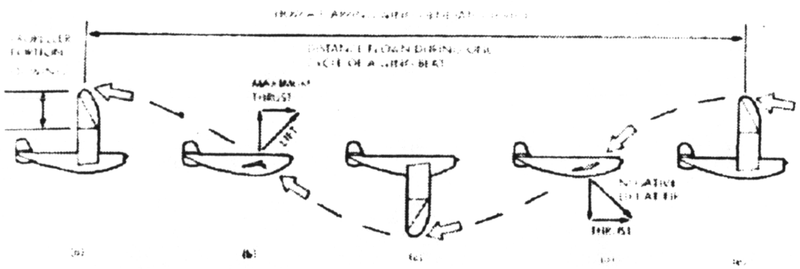
It is necessary to provide this feature, for without it, there could never be a guarantee that the wings were in the correct position for a glide, and return to propeller power for subsequent landing.

To date, this aspect of the wing flapping mechanism has functioned satisfactorily during ground trials, and it has been tried twice whilst airborne with the wing subjected to flight loads. The most uncertain aspect of this mechanism is the reliability of the engine.

Should the sudden shock of the wing flapping stall the engine, there is no way of returning the wing to the glide position. The prospect of flying the model with a wing in an exaggerated anhedral position fills one with horror!

The model first made one flight in the rigid mode and was airborne for about three minutes, just enough to prove that it would fly by means of a propeller. At least it is known that the wing mechanism and structure can take the air loads and that the wing leading edges doesn't twist uncontrollably. In August 1978, the power was transferred from propeller

Two pioneers, left, the doyen of British radio controlled modelling Howard Boys and right, John Drake the originator of home built helicopters and now ... the ornithopter seen at an Aeromodeller rally, Old Warden



These five sketches show the wing tip, at the top, middle and bottom of its beat during one cycle. The dotted line traces the path of the wing tip during this cycle. The wide arrows show the angle at which the air stream apparently meets the wing tip at each instant.

The leading edge of the propeller portion of the wing is caused to move up and down, synchronised with the wing position so as to allow the airstream to meet the leading edge cleanly. Strange as it may seem, the mere action of oscillating a wing up and down whilst moving forward, actually produces thrust by virtue of the fact that lift is always at right angles to the airstream. So that in position (b) the lift is angled forward giving a resulting thrust. Thrust is generated between position (a) to (c) reaching a maximum at position (b). There is no thrust at (a) and (c), but there is a small amount of forward thrust at (d), provided a small amount of negative lift is tolerated on the outer portion of the propeller.

The peak velocity of the wing tip during the down beat must be at least ¼ of the forward velocity for there to be any useful thrust to keep the model airborne. The flapping rate of three beats a second is the predicted requirement to fly the model.

to wings at 200 ft. altitude and the immediate result was a fast roll! Fail safe return of the wings to glide mode worked and a safe landing resulted. So far so good!

MODEL SPECIFICATION

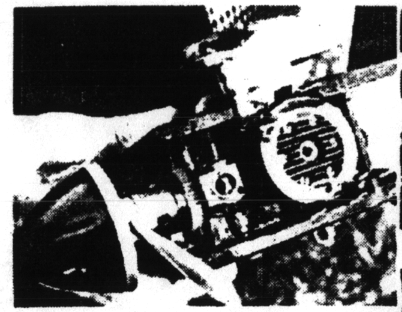
Engine: Merco 29 with a homemade heat sink to keep the engine cool when the propeller stops and the engine is working hard flapping the wings.

Wing span: 68 inches.

Weight: 6 lb.

Construction: Very conventional, sheet fuselage as on modern power models. Tricycle undercarriage.

Wings: Built up, using ribs and spar etc. The wing is covered with Solarfilm. A symmetrical section was chosen to overcome difficult geometric problems around the pivot points on the wings. Each half of the wings is made up of three hinged sections, all driven in the correct phases, one to the other to provide the maximum thrust during the down stroke, and to minimise the reverse thrust on the up stroke.



DRAKE ORNITHOPTER DETAIL

Above, the power unit with clutch drive to propeller and heat sink on cylinder for cooling when drive is disengaged from the prop. Underside view (below) reveals the gear drive shaft which activates the flapping mechanism through another gear box hidden in centre section. The clutch is simple and effective.

SEQUENCE OF WING FLAP

Right: a five-stage sequence of wing activation. Top: the wing in the "fail safe" glide position.

Next: the wing halfway through its downbeat.

Third photo shows the wing at the bottom of its down stroke.

In four the inner section of the wing is in advance of the outer tip (the propelling part) on the up stroke.

At bottom, the inner section of the wing has reached the glide position while the propelling section has still to move upward.

These photos were taken using the Editor's motorised camera during a demo drive by using a motor starter. Draughtsman Pat Lloyd who prepares the *Annual* drawings, is holding the fuselage.