



**JIM BAGULEY**

*writes about*

# POWER DURATION MODELS

I DO not claim to be a top line power modeller, but, by writing this article, I hope to stir up some thoughts about power duration model design, especially if it results in the topic becoming controversial!

I have restricted myself mainly to the most interesting type of contest power model—that using as much power as can safely be trimmed. Although I have devoted most of my remarks to the design and trim problems of the model, it must be emphasised that the most important factor in competition flying is the way in which the model is flown. This is largely a matter of experience. No matter how good a model is, it will not be able to achieve consistent results if handled badly.

Where there are inaccuracies in my descriptions of other models' characteristics, I apologise. It is impossible to be 100 per cent. accurate where ideas and impressions are largely a matter of opinion. It also takes some courage to "stick one's neck out" when writing about something no one else has been outspoken about in print for five years, but someone has got to do it, so here goes! J.B.

## The Pylon Model

*The wash-in and tail tilt trim with same turn direction for power and glide:—*

This is the trim which seems to be the most popular at the present time, and it has shown itself to be capable of handling very high power. It is usually a right-right trim and with this flight pattern, the pre-flight adjustments are as follows:—

Some differential wing warp is built-in to roll the model against turn, i.e. left, and this is usually—when using polyhedral—in the form of wash-in on the starboard inner panel, and possibly slight wash-out on the port inner panel. The extreme tips of both wings are washed-out to prevent tip stalling and

thus help the rate of roll and pull out. This is achieved our desirable left rolling moment (explained later).

On the glide the wash-in on the starboard wing may produce a turn to the right, as the drag may be greater than the increased lift, but in any case, the turn will be insufficient. Slight right turn may also be useful under power, and a way in which to achieve this, and give glide turn, is to employ tail tilt (starboard side tilted up). The effect of this under power, as compared with the effect during the glide, will depend upon the model layout and the c.g./incidence situation which is explained later. Suffice to say for now that as the c.g. is moved aft, and the

longitudinal dihedral reduced, the less the effect will be under power compared with that during the glide.

The reasons for the applied left roll due to the wing warps may be explained as follows:—

It is assumed that whatever the angle of climb it will be safest if it is of helical form (i.e. spiral climb). This applies irrespective of whether the model is climbing at 45 deg. with a "roly-poly" trim, or a wide 60 deg. sweep with maybe only  $1\frac{1}{2}$  turns in 15 sec., or a near vertical climb, with little turn but rolling about a longitudinal axis. The theory being that if the model is in any way deflected from its helical natural flight pattern, it will momentarily assume one which is still helical, but may have different helix diameter, helix angle, helix inclination, etc., before returning to the original pattern. The helical climb can, therefore, cope with any sudden gusts.

For those who find it difficult to visualise that a right spiralling model is rolling left to some degree, imagine a model climbing at say 45 deg. in a normal circling right-hand spiral. Now gradually (in your imagination) steepen the climb angle and lessen the turn, while maintaining a spiral or helix, and keep going until the model is climbing almost vertically with little turn. It will be seen that the model is virtually climbing vertically and rolling *left* about its longitudinal axis.

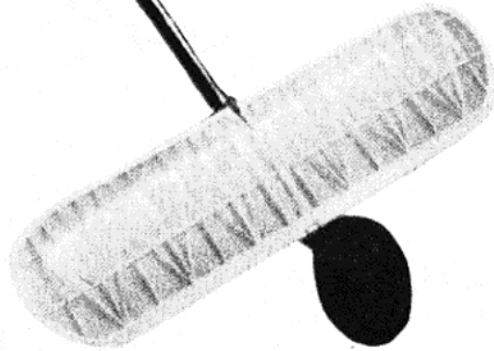
The left roll is therefore necessary for a safe spiral climb and if the left roll due to torque is insufficient, and there is no rolling moment, a spiral climb may be tricky with *high* power, resulting either in loops, or a spiral dive. A spiral climb is, in any case, merely a loop deflected into a spiral by means of applied roll and turn.

Overdoing the left roll can be interesting, especially if the model was trimmed to climb at about 75 deg., as the left roll gradually takes over (usually after 200 ft.) and the model then goes to horizontal left rolls, and then vertical left rolls but vertically *downwards*! Should the model survive this manoeuvre the cure is either to lessen the warps, or increase the turn by means of the trim tab.

If the longitudinal stability of the model is rather borderline, instead of a smooth transition to the glide it may do left rolls vertically downwards. The solutions here are to retrim with the c.g. further forward, to increase the power so that the model rides over the top of the climb into the glide, or to retrim for a shallower spiral.

The symptoms of maladjustment under power may be summarised:—

**PART I**



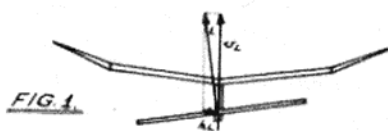
- Insufficient left roll—spiral in or loop.
- Too much left roll—left roll (but not in upward spiral).
- Insufficient turn—loop.
- Too much turn—shallow climb or spiral dive.
- C.G. too far forward with too much longitudinal dihedral—loop.
- C.G. too far back with too little longitudinal dihedral—right spiral dive, or lack of pull-out, or inconsistency of helix angle.

The above list is a basic guide, the only way to be sure of a diagnosis is by flying experience as other factors may enter the picture, e.g. model proportions (discussed later), engine offsets, etc.

The effect of precession (gyroscopics) has been ignored, as if the model is trimmed to climb steeply, as it should be, then the effect of precession is not worth worrying about, especially if the model is launched in its climbing attitude. The effect of precession is, however, to provide a nose-up moment to a left climbing model and the reverse to a right climbing model.

Should this wash-in, tail tilt trim be used on a model with a left-left flight pattern, it should be remembered that a right rolling moment is required to be induced, and this will require greater warping as the left rolling moment, due to torque, will have to be cancelled. This may mean excessive warping which may cause trouble, and for this reason a left-left climb with this trim is not recommended.

The effect of tail tilt should now be explained as it will be useful for further trimming. The turning effect given by tail tilt is caused by the tail lift acting at an angle to the vertical axis of the model, this will give a sideways lifting force as the lift may be resolved into two vectors—one horizontal, one vertical. This is shown in Fig. 1 where "L" is



the tail lift, "vL" is the vertical component, and "hL" is the horizontal or turning component. In glide conditions when the tail lift is a predominant factor compared with the fin (and other side area effects), a definite turn will be caused by the resultant "hL."

On the climb the whole model will be moving much faster, but although the tail will still have lift, as will the wing, the side areas (fin, etc.) will have come into their own and any turning effect, or otherwise, which they may have, will far outweigh the effect of the tail tilt.

The effect of tilt on the glide (before it reaches a ridiculous magnitude such as will noticeably affect the power) is dependent upon what proportion of the total lift is borne by the tail plane. If the model has a short moment arm,

e.g. well forward, and a considerable longitudinal dihedral, it is obvious that tilting the tail will have comparatively little effect, as this component is bearing only a small proportion of the total lift. If, on the other hand, the model has a long moment arm, e.g. well back and little longitudinal dihedral, then the opposite will apply.

The foregoing trim has been described in detail as it is very widely used. There are many other types and variations, so many that it is not possible to consider them all. I will, however, sum up a few in general terms, and also include some trimming gadgets.

#### Thrust offset and rudder trim

This, apart from the "let go and hope" trim is the oldest, as it is the most obvious. The basic idea is, using low power, to trim for the glide by varying wing and/or tail incidence and rudder setting and then to trim the power by using thrust offset.

The pattern may be left-right, right-left, straight-right, etc., but the success

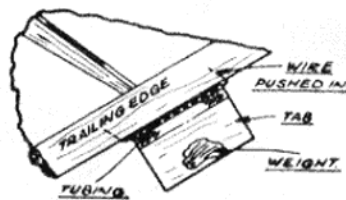


FIG. 2 DRAG TAB.

of this trim will depend upon the design and it is not recommended for highly-powered models.

An obvious disadvantage is that if the turn under power, and glide, is in the same direction, should the model bank in the direction of rudder offsets, this offset will be turning the model downwards. The effect of thrust offset may also be complicated by the effect on side areas. The characteristic climb pattern of a model of normal proportions with this trim is a "roly-poly" spiral which, while it may be very safe, is rather inefficient.

#### Straight climb trim

This trim is achieved in several ways, usually the aim being to produce a straight 70 deg. climb into wind with a flick out at the end into the glide. The glide circle being obtained by a trim tab, auto rudder, tail tilt, or drag tab. In the latter three cases the effect of the glide turn on the power pattern being negligible or nil.

The "in the groove" characteristics needed for this trim may be achieved either by the layout of the model, or by downthrust. The layout requirements include a long moment arm, combined with a large tailplane and small longitudinal dihedral with rearward c.g. unless downthrust is to be resorted to. This trim tends to be dangerous as, if downthrust is used, and the model is at some time subject to underelevated

conditions (gusts, etc.) it may stay that way! Also with this layout the transition to glide may be dangerous especially if the climb is steep, unless flicked into the glide by auto rudder.

#### General trim

The first type of trim mentioned is recommended for general use with highly powered models, but it is not claimed to be the ultimate. A trim with different circling directions on climb and glide is generally to be avoided, as it usually means a bad pull-out or excessive climb trim to cancel the glide trim.

#### Drag tab

This is normally situated on the wing trailing edge some way out. It is usually a hinged tab which is weighted so that it hangs freely. On a steep climb it may be "blown" straight, thus producing little effect. It will hang down on the glide, causing the model to turn to the side on which it is attached by increasing the drag on that side. See Fig. 2.

#### Auto rudder

This is similar to those used on gliders, but instead of being actuated by the tow-hook, is actuated by a timer, usually at the same time as, or immediately before, the motor cuts. It is normally straight on climb and turned for the glide (Fig. 3).

#### Other gadgetry

The system used by Bond Baker on his long moment arm F.A.I. power model, was a cam arrangement on one side of the tailplane which raised it at that side under power, removing the tail tilt and, at the same time, increasing the tailplane incidence. This method proved most effective on Baker's model, giving it a near vertical, almost straight climb, but a side wind launch during the '58 Championships nearly caused a crash before the model built up sufficient airspeed to climb.

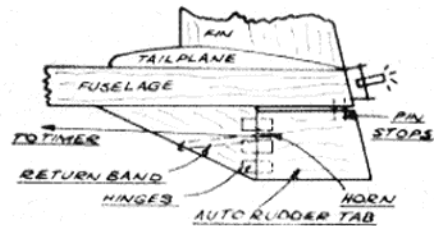
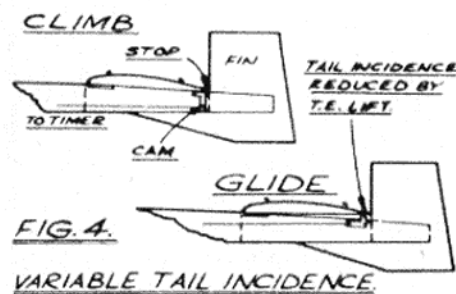


FIG. 3. AUTO RUDDER.

This system, in common with the more usual systems of just increasing tailplane incidence or decreasing wing incidence under power, enables a model to be flown with the c.g. further forward, which may give a safer pull out and a more consistent glide if operated at the correct moment. Dave Posner has recently been experimenting with the decreased wing incidence method with promising results, and this should be recommended enough. A cam arrangement is shown in Fig. 4.

It is better for the wing or tail to be lowered by the cam operation, as this requires less effort on the part of the timer, but this means, in the case of the tailplane, that the leading edge must be actuated, which may mean a double cam, as the leading edge is used more for location than the trailing edge.

In the arrangement shown in Fig. 4 the tailplane trailing edge is raised by the cam, but part of the tailplane only may be made to alter in incidence, i.e. a trailing edge flap. A pendulum



actuated tailplane trailing edge flap was used by Max Byrd as early as 1932, and even now this would seem to be a good idea provided the system is well designed and the pendulum suspended at the c.g. of the model.

There are many other trim gadgets in addition to those mentioned here, but this is a representative selection applicable to pylon models.

### The High Thrust Line Model

#### The Bethwaite trim

Bethwaite's own explanation of this trim (see Fig. 5) is interpreted thus:—

The basic idea is to allow the model to loop, but to also apply a roll which is in phase with the loop, thus producing a spiral. A left hand turn is used, and as the climb is relatively shallow there is a powerful precession nose-up moment. The lower part of the rotating slipstream from the airscrew impinges upon the low side area and the wing, thus producing a left turning and right rolling moment, this being at a maximum when the model is moving slowly, i.e. at release.

The precession moment is also at a maximum at release. The net effect of this is to rapidly roll, turn and lift the model until it reaches say 50 deg. to 60 deg. then the spiral opens out and becomes more shallow. If the speed at any time becomes excessive the model straightens and loops, thus lessening the likelihood of a spiral dive. His design seems to require a remarkable amount of downthrust, but the main objection to this trim is that with a very highly powered model, a 45 deg. or so spiral does not usually provide the greatest altitude.

#### Early Stan Hill trim (Amazon)

The original Amazon (Fig. 6) seemed to be trimmed to climb vertically with no roll or turn.

I believe the model was warp free, had close wing and tail rigging angles, with rearward c.g., sharp leading edged airfoil and little downthrust.

This would give a loop of vast diameter, the motor cutting when near vertical, from a horizontal take off, with long run. Any glide turn presumably is set by the rudder, with sidethrust compensation on the climb. The objection to this trim is that if the model was at any time in difficulty it would have comparatively little chance of recovery. Other examples of this design, and the later version of Amazon seen in action, have had a safe left spiral at a shallow angle which gains them a respectable height, but it is on the glide that the model really scores.

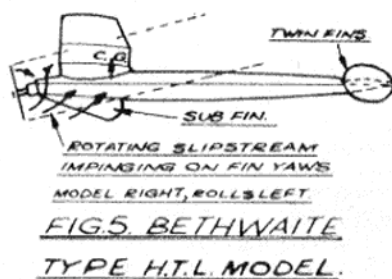
It has been said of this type of layout that as the centre of the area in the slipstream is behind and below the c.g., the rotating slipstream will roll and draw the model right, thus making a left climb safer. I would agree with the right roll, but am doubtful if the side area beyond a limited distance back would be affected by the rotating slipstream, especially an upper fin, which would be directly behind the wings and fuselage. This has no effect on the validity of the theory behind the Bethwaite design (see Fig. 6).

#### Natural downthrust trim

This trim, if highly powered, generally results in a loop, made safe with down and sidethrust, although it has proved safe with low powered models such as the earlier Belgian International Class designs.

#### Excessive low drag

Another method of killing the looping tendency of a high thrust layout due to the wing but not the tailplane being in the airscrew slipstream was to have the



motor mounted at the top of a pylon, in front of, and above, the wing. The moments of wing and fuselage/tail drag about the motor were then roughly equal, and if the tailplane had sufficient power the loop diameter was very large.

#### The new Stan Hill type of model

This trim or layout can be seen in Fig. 7. The idea is to do away with excessive downthrust, either of the built in or added variety, and to maintain a safe climb; using greater longitudinal dihedral for a better pull out and a more consistent glide. The latter should be

fulfilled, even with the high c.g. if sufficient dihedral is maintained.

The nose down moment due to the high thrust line, would probably admirably replace the normal nose down moment on a pylon model due to the slipstream impinging on the tailplane and downwards, even though there is greater longitudinal dihedral. Only the motor mount fin, and possibly the rear fin, are in the airscrew slipstream giving better usage of power.

The rotation of the slipstream affecting the forward fin will turn the model left, but if the fin is carried above the thrust line this may be cancelled. The action of the slipstream on the rear fin may also give left turn, provided the slipstream

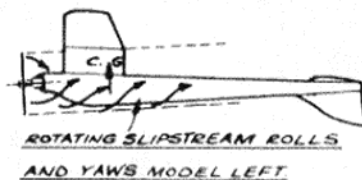


FIG. 6. EARLIER HILL TYPE H.T.L. MODEL.

is still rotating when reaching this point. (It may be assumed that this is so, as the slipstream path is relatively unhindered.) This, together with the left roll due to motor torque reaction alone, and the large diameter loop, will give a steep very slowly rolling right climb, but Stan Hill prefers to use slight left or straight climb. The design uses tail tilt for right glide turn, a large tail moment and a forward c.g.

This layout would seem to be well worth trying, although it is noted that the Hammerhead itself is a very large model for a 2.5 and I wonder what trimming problems there would be if the model were more highly powered; anyway, well done Stan Hill for getting out of the rut, with an original layout!

#### Further trimming techniques

Many layouts which are basically unsound may be perfectly safe if the model proportions suit them; just as conversely a basically safe layout may be unsafe if the model proportions do not suit it. General design considerations will be discussed after several well known models and their trims have been analysed. It is hoped that the owners may forgive any discrepancies as it is impossible for anyone to know everything about another person's trimming or reasons for any model's peculiarities.

The majority of the Surbiton club seem to use the wash-in and tail tilt on pylon models; indeed, certain members of that club would seem to be the originators of this trim (or Tom Smith with friend Tritler or maybe Brian

Continued overleaf

Eggleston of *Creep* fame, or Marcus's *Eureka*, certainly it was the Surbiton club who showed me the way.

Dave Posner's earlier models had the true, near vertical, spiral, but of late the spiral seems to have opened out slightly to more nearly approach Gaster or Jays' trim in which the model climbs at 60 deg. plus, with little turn or roll, and a very large loop diameter giving perhaps four turns in 15 sec. The man who has blazed a long trail of success with this wash-in/tail tilt trim has been George Fuller who, I would say, uses it to its best advantage on his very small model.

The Buskell trim is one on its own, being a high rate of roll and a pull out with no loss of height; the detail trimming of *Slick Stick* is a mystery to me and I have yet to see anyone else produce the same results with a this model. In

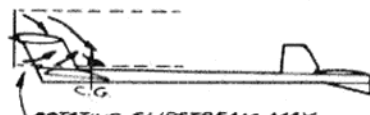
fact it appears to be a one man model, as one proxy flier found out!

The fastest climbing models I have ever seen were those Tom Smith flew at the '58 Nationals, where he seemed to have made his usual layout slightly more conventional. The trim would seem to have been an 80 deg. spiral of negligible roll and turn (in effect straight up at 80 deg.!) but it was not consistent even in the calm weather, one of the models "flew over the hump" to pass from steep climb to horizontal and then steep dive!

The models themselves were very advanced, being exceptionally lightly constructed and although having normal areas, had very thin airfoil sections and used an auto rudder. The propellers were also a lesson, being very wide bladed and making efficient use of the engine power, this in contrast to the

narrow-bladed Surbiton type propellers.

Ron Draper's models seem to use a "straight up" trim with slight down-



GIVE SLIGHT RIGHT YAW

FIG. 7. NEW HILL TYPE

H.T.L. MODEL

thrust and long moment arm, there being no tail tilt, etc. The glide circle is obtained by auto rudder and drag tab. The use of wash-in on the port tip is mystifying however. These models usually seem safe, especially those built by John Bickerstaff.

To be continued next month

## ALL HOGWASH

Continued from page 309

favrit dungenne, where ye hapless serf didde dispire."

"Well, what d'you think," enquired Ted of the dazed members, "Genuine, or a Crummy forgery?"

Salty answered by asserting that if that piece of history wasn't bunk, then the Black Prince defeated the Armada with a combat model.

One or two of the members remained unconvinced, in spite of both the obscure serf and Crummy bearing the same blot on their respective escutcheons; the name Crummers.

"Well, of all the wet lot," cried Ted, "Use a bit of common, for Chobham's sake. Every character who comes to a sticky end in the old ruin does his nightly stint in the unmentionable tower. And, while I've heard of all sorts of ghosts up there, headless and otherwise, I've never heard of a model flying one."

Salty had a bright idea.

"Just to make sure, why not get Little Willie to do a spot of ghost watching. Armed with a copy of Hector Plassem's Guide to Hogwash Ghosts, he could check 'em off as they come on duty."

Willie jibbed at this.

"No fear," he wailed, "I had enough of it when we held that indoor meeting in the Banqueting Hall. Me microfilm job got stuck on the balcony. So I climbs up after it. Bit dark up there, and I sees something flimsy, which I takes to be me model. Makes a grab, and gets hit on the head with a ball and chain."

"That's the excuse all the village idiots make," remarked Salty.

"At least when I saw the ghost of Sir Ould Ffoulkes, with his head tucked under his arm, I didn't offer him a tube of cement," retorted Willie.

The idea of the ghost hunt was abandoned when, a week later, the *Advertiser* came out with a yet more sensational stroke. It announced the holding of a special competition to commemorate the 500th anniversary of the first model plane crossing of the Sludge. Local luminaries had chipped in generously towards the prize money, with the exception of Farmer Glossop, who regarded Baron Prospeck's treatment of modellers as a shining example.

The prize was to go to the owner of the model making the most novel and spectacular crossing of the Sludge.

"Now we can see the light," exclaimed Ted. "But I think I know how we can put paid to Crummy's little game. Now, chaps, this is what we do. . ."

On the day of the contest the whole of Hogwash turned out in force, partly out of curiosity, but mostly to keep the horde of visitors off the hollyhock beds. News of the unique contest had spread far and wide. The fact that it was to commemorate the first model flight touched the National Pride. No doubt the Russkis were already digging furiously into their history books, but five hundred years had given the old country a flying start.

The cattle track to the Sludge embankment was jammed solid with cars, coaches and vehicles of all descriptions, as Ted and his clubmates made their picturesque way to the contest site. Each was tricked up in the manner of a medieval serf, which was odd, and each carried a medieval looking model, which was not so odd. They were given a resounding cheer by the coach parties, and jollied on their way with a discordant rendering of "Robin Hood."

When they reached the river bank there was Crummy, dressed medieval-

wise, as Ted had expected. But far from having his already disjointed nose put further out of joint by the sudden appearance of a dozen similarly clad medievalists, he seemed quite unperturbed.

"Let's just ignore him," suggested Ted, rather disconcerted at Crummy's lack of response. He and the others then turned their attention to the frenzied activity along the riverbank.

Many were the quaint and enterprising means by which the prize-happy contestants were hoping to negotiate the murky waters of the Sludge. Most impressive was a radio controlled Serf model, while at the other end of the scale, Little Willie Wilkes's even more diminutive brother was preparing to tow across a rotor kite while swimming under water with a snorkel.

One of the first machines away was an ingenious magno control effort. A large hand-cranked electro magnet, stacked in a rowing boat, provided the attraction. Unfortunately, a slight technical hitch—the sudden immersion of the boat—caused the model to veer off course. It was later found affectionately nudging a distant gasholder.

Another plucky assault by rowing boat was made by a combat character, doing his circulating from a platform in the boat. All went well until he caught a foot in one of the rowlocks. Undismayed by this mishap the model carried on in ever decreasing circles, until the combat character was bound head to toe with such fiendish thoroughness that it would have won the approval of the Baron himself.

The Hogwash boys fared little better. The only splash they made was the watery one of models plopping one by one into the green depths. Only one medieval type model flew the course, landing bang on the mangelwurzel target. The judges were enthusiastic.

"Looks like old Crummy pulled it off after all," remarked Ted, dejectedly.

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