THE DYNAMICS OF THE WINCH LAUNCH

by Harold Drew

Have you ever tried to explain a winch launch to someone who has never seen one and is at the same time something less than a mechanical genius? I have found such endeavors singularly unrewarding. "But how," says the poor sap, "can you make a sailplane climb by pulling it down with a cable?" One shrugs one's shoulders and gives it up, compensated, perhaps, by a pleasant illusion of one's superior understanding. At least, this is the way I felt until recently when I rashly volunteered to give a talk on the subject. I soon realized that I had just accepted the facts without bothering to analyze them.

Later, I discovered that sailplane pilots, when they begin to think about the process, are intensely interested. Although there must have been articles written on the principles of the winch launch in a dozen languages, the editor tells me that he has no knowledge of such an article published in Soaring.

I propose to take all kinds of liberties with aerodynamical theory (of which I am entirely ignorant) and treat the subject from the point of view of the practical pilot and the man on the winch, who rarely possess more than an elementary knowledge of mechanics. The purist need read no farther.

The Center of Gravity Hook

The barbarous practice of winch launching with a nose hook will surely soon become extinct and I shall confine myself to the art of winch launching with the so-called C. G. (center of gravity) hook.* The C.G. hook is not often situated at the C.G. of the loaded ship (for one reason because this point usually is inaccessible, occurring, as it often does, a short distance behind the pilot's navel). For obvious practical reasons, the hook is usually placed close to the keel. It doesn't even lie immediately under the center of gravity with the ship in level flight. If it did, then, when the ship is climbing on a launch, the line of the cable pull would pass to the rear of the C.G. and center of lift. This would pull the tail down and require forward stick. Designers prefer an arrangement which calls for a little backward stick. Then, if a pilot unintentionally releases the control stick, the ship automatically drops its nose which is a lot safer than having it rear up on its tail. Also, it will be noticed, this slight tendency to pull the nose down increases as the angle of climb is increased and thus automatically tends to limit the angle of climb.

A C.G. hook should never be used without a weak link in the hitch. The combination of a C.G. hook, a powerful winch, a heavy handed winch driver and an inexperienced pilot can be dangerous in the absence on an appropriate weak link. The recommended breaking load for the weak link can be obtained from the designer of the sailplane. With a weak link, the C.G. hook is safer than the nose hook because, if the cable parts on the nose hook tow, the ship rears up, whereas with a C.G. hook, the trim is hardly affected and the ship is thus more quickly brought into a safe attitude.

Apart from questions of safety and convenience, the C.G. hook brings a useful bonus. A thousand feet can be gained with a C.G. hook in conditions which would limit the same ship to 800 feet with a nose hook. This is because we do not have to fly with the stick in our lap and with the elevator behaving like an inverted flap; also because our speed is not limited by porpoising.

The Winch

It will be assumed that we have at our disposal a winch having an ample reserve of power and preferably equipped with a tensiometer indicating the cable tension. (See the May-June, 1958, issue of Soaring for a description of such a winch.)

The Take-off

Our object is to get the ship off the ground with the shortest possible run but without straining the gear or embarrassing the pilot. This requires judgment on the part of the winch driver. For the take-off we need tension in the cable for three distinct purposes; to overcome rolling resistance; to overcome aerodynamic drag; to accelerate the ship. The rolling resistance on rough grass runs about 50 lb. per 1000 lb. of weight with the small tires we use: Thus a loaded ship weighing about 500 lb. (about as light as they come) requires about 25 lb. tension to overcome rolling resistance. As the ship approaches flying speed, the weight carried by the tire diminishes and, at take-off, falls to zero. Thus the rolling resistance also diminishes and falls to zero at take-off.

While this is happening, the aerodynamic drag is increasing. Before the ship moves, the drag is dependent on the wind velocity. At take-off, say at 44 mph air speed, a 500 lb. ship with an L/D ratio of 23 will have a drag of 22 lb.

During take-off, therefore, we need a horizontal tension in the wire of around 25 lb. to overcome the combined effects of rolling resistance and aerodynamic drag.

We now come to the third purpose for which we need cable tension. We all know that we need force to overcome inertia and accelerate the ship. If we use a force of 200 lb. to accelerate 500 lb. of ship and pilot, we shall subject them to an acceleration of .4 g which seems not unreasonable. If we could apply such a force steadily we should need 160 ft. to attain a ground speed of 44 mph which is usually adequate for a take-off in still air. The process would take 5 seconds. This is just about what we achieve in practice. A take-off in still air thus calls for a horizontal cable tension of 200 lb. for acceleration plus 25 lb. for rolling resistance and aerodynamic drag. As in the affairs of man, the major factor at take-off is evidently the force to overcome inertia.

The Climb

To Agur, the son of Jaketh, there were four mysteries beyond his understanding and one of these was "The way of an eagle in the air" (Proverbs 30, 18). Had soaring been popular in his day, he might well have added "and the way of a sailplane on a winch launch." No one would have told him about vector diagrams, the simple device by which we represent the interaction of forces.

Whilst our glider is traveling horizontally we do not have to bother with vector diagrams in order to add up our horizontal forces, but once the ship starts to climb, we are confronted with four forces, all acting

*Of the 7 ships commonly operated at Big Beaver, Mich., by members of the Vultures club only one is still without a C.G. hook.