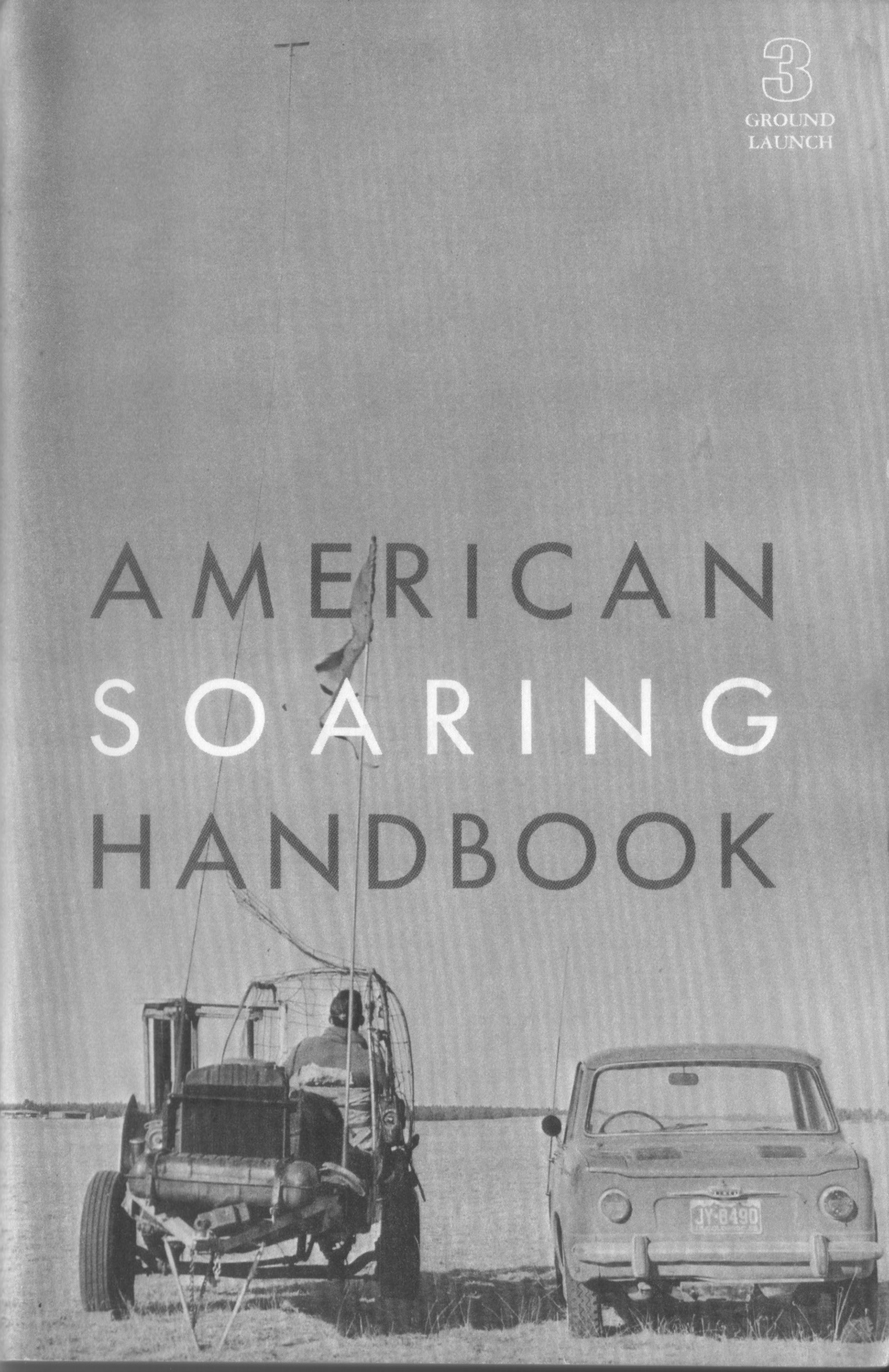

3

GROUND LAUNCH

AMERICAN SOARING HANDBOOK

3. GROUND LAUNCH

author	WILLIAM R. FUCHS
editor	ALICE S. FUCHS
book designer	LELAND C. SMITH
editorial advisor	TOM PAGE
cover photograph	WERNER THANNER

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AMERICAN SOARING HANDBOOK

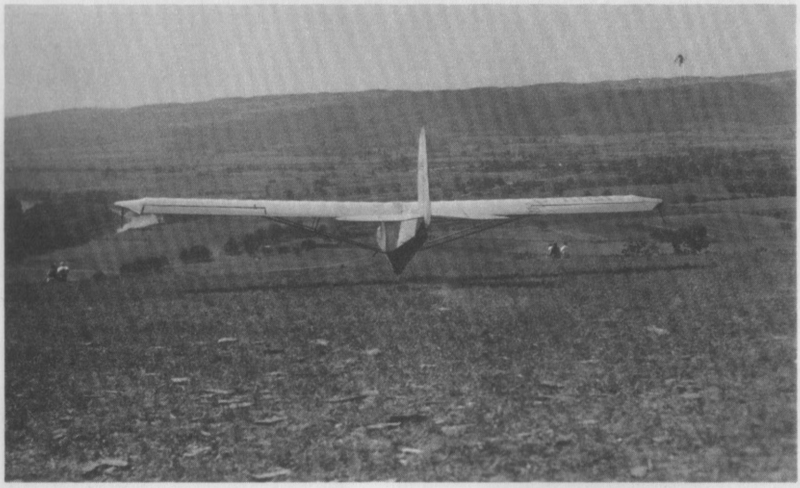
GROUND LAUNCH

WILLIAM R. FUCHS, author of this chapter, holds an FAA Commercial Certificate with a flight instructor rating for airplanes, gliders and instruments. While a faculty member at the United States Air Force Academy, he initiated and directed the first Academy soaring program, conducting the training of glider instructors and cadets. He has had extensive experience in both winch and auto launch.

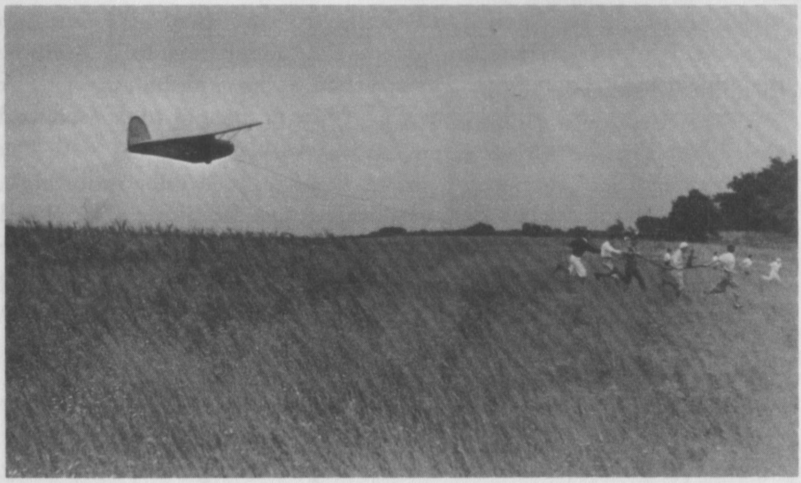
1 INTRODUCTION

In the early days of gliding, gliders were launched from the top of a hill into a wind by means of bungee cord, a stretchable cord made up of rubber bands, and similar to that used on Piper Cub airplane landing gears. The tail of the glider was held back or tied down and the bungee was attached at its midpoint to a hook on the nose of the glider. Then a group of people took each end and when the signals were given they walked, then ran with the bungee as hard as they could. When the tension became quite high, the tail tie-down was severed or released and the glider shot ahead as though it had been launched from a slingshot. Launches were made from the top of a hill and, if there was a brisk wind blowing up the hill giving some lift, the pilot got a nice ride to the bottom of the hill.

As gliders got heavier and better, pilots began to look for better ways to launch. It was not long before enthusiasts began to use cars to pull shock cords and then to pull the gliders by a long wire or rope. Then someone struck on the idea of using powered winches.



Shock cord launches were made from hill tops with the gliders landing on the fields below. Photograph by Fred T. Loomis.



Shock cord launch of Franklin PS-2 in 1932. Photograph by Fred T. Loomis.

By car or winch launch a pilot could get to higher altitudes, where he was safe to spend some time and altitude searching for lift. These two methods will be discussed in this chapter. The other popular method for launching a glider is by airplane tow, which is discussed in Chapter 4. From the point of view of the pilot, winch and automobile launches are so similar that they will be discussed in one chapter.

A car tow is conducted by attaching one end of a rope or cable (900 to 1,500 feet long) to the tow hook of the sailplane and the other end to the car. The car is driven at high speed down the roadway and the aircraft is launched much as a boy launches a kite by running with it. Figure 1 shows the sequence of events of this type of launch.

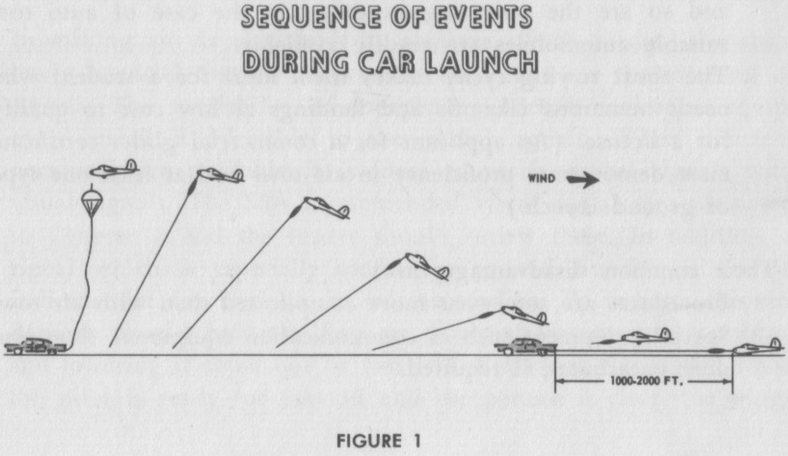


FIGURE 1

In a winch launch, the moving car is replaced by a fixed winch which resembles a powered fishing reel. As the reel winds in the cable, the sailplane is pulled at flying speed, climbing just as it would if it were being towed by an automobile. Figure 2 illustrates the flight path followed by the sailplane during a winch launch.

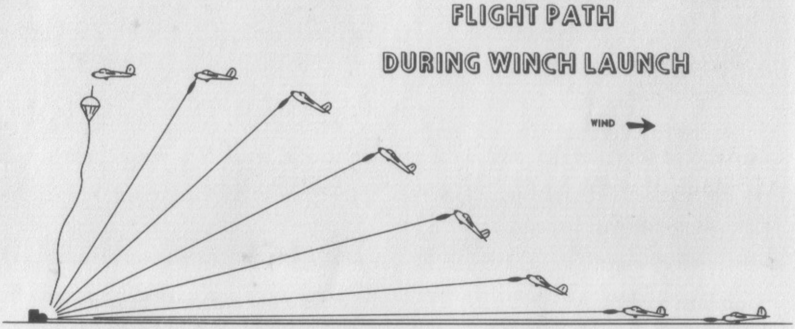


FIGURE 2

Winch and car launching have the following common advantages:

1. They can be used in open fields which are not true airports, and hence more sites are available.
2. Tow equipment is considerably less expensive than a tow plane, and so are the operating expenses. In the case of auto tow suitable automobiles are readily available.
3. The short towing cycle, makes them ideal for a student who needs numerous take-offs and landings at low cost to qualify for a license. (An applicant for a commercial glider certificate must demonstrate proficiency in air tows and at least one type of ground launch.)

Their common disadvantages are:

1. Procedures are somewhat more complicated than with air tow.
2. Special equipment such as communication equipment, flags and drag parachutes, is required.

3. Maximum release altitude is limited.
4. Release position is over the runway. Hence one cannot cover much ground or stray far from the airport in searching for lift.
5. Suitable cable is sometimes difficult to find and is usually expensive (4.5¢ to 7¢ per foot) when it is purchased.
6. Poor technique or improper wire or rope can, and often does, result in exasperating snarls, which are usually time-consuming and frustrating to correct.
7. For a speedy operation these methods require one more ground crewman than do air tows.
8. Tow cable failure requires prompt response on the part of the pilot, and can be somewhat hazardous under poor conditions of traffic or terrain.
9. These launching methods are often not welcome at airports because of the interference they may cause with other traffic.

The fact that the number of disadvantages is greater than the number of advantages is not justification to discard these two launching methods, for the saving in cost per launch is a highly weighted advantage to most pilots.

2 *SIGNALS USED FOR AUTOMOBILE OR WINCH LAUNCHES*

In making any launch, be it by airplane, winch or car, it is absolutely essential that all participants know and use the same set of signals. The availability of inexpensive telecommunication equipment makes it advisable to use verbal signals. When sufficient personnel are available it is ideal to verify verbal signals with visual signals. The SSA recommended visual signals are presented in Chapter 2 and the reader should review these. In addition, a signal which is especially useful for ground launches is one to indicate that the slack is out of the towline. To indicate this the flagman should hold the flag out horizontally, alternately raising and lowering it about one or two feet. Following this signal, when the pilot is ready for take-off and the pattern is clear, the wings are levelled and the flagman rotates his flag continuously through 360 degrees to signal the car driver or winch operator to apply power for take-off.

3 *SAFETY LINKS*

A safety link (weak link) *must* be used for all ground launches to prevent overloading the sailplane and to provide a last-chance means for the pilot to get rid of the towline if neither his manual nor his automatic release functions. This link consists simply of a piece of specially selected rope which is in good condition and has a breaking strength within the range of one to two times the gross weight of the sailplane. If this rope is too weak there will be too many breaks, which give rise to semi-emergency conditions and cause delays; if too strong, it will not break when it should.

The safety link must always be attached directly to the tow hook of the sailplane. A drag parachute, which is essential when wire is used for launching, must always be placed ahead of the weak link. A five-foot piece of good 3/8-inch Manila rope is a satisfactory weak link for most single- and two-place sailplanes used in the United States.

Care should be taken to ensure that the proper type of ring is spliced onto the end of the safety link which attaches to the tow hook of the sailplane. Small foreign rings or mild steel rings used on harnesses for horses will wedge in some sailplane tow hooks, thus creating a hazard. The Schweizer Aircraft Corporation offers excellent rings for this purpose.

4 *SAILPLANE TOW HOOKS*

The type of hook which is used on the sailplane for ground launching must be one with an automatic release which will open as the tow wire approaches the vertical or beyond. It should be designed so that strong tension caused by a pilot's improperly pulling up hard toward the end of the run when the wire is nearly vertical will not lock the hook and prevent release. Duplicate arrangements for pulling the release are not common in most U. S. sailplanes, but are a safety feature which has been included in some sailplanes and has some merit.

A type of tow hook which has proved very reliable in Schweizer sailplanes and others is shown schematically in Figure 3.

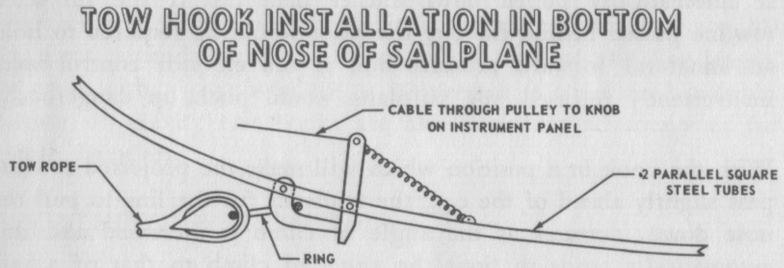


FIGURE 3

The ideal location for the tow hook of a sailplane which is to be launched by air tow is at the nose of the aircraft near the longitudinal axis. A tow hook which is located farther back on the belly of the fuselage gives far higher winch or car tow launches, but is dangerous if used for air towing because it tends to pitch up the nose of the sailplane. Most designers locate their hooks in a compromise position between these two. If a sailplane is to be launched most of the time by car or winch, a c.g. (center of gravity) hook is a worthwhile investment. (See Figure 4.)

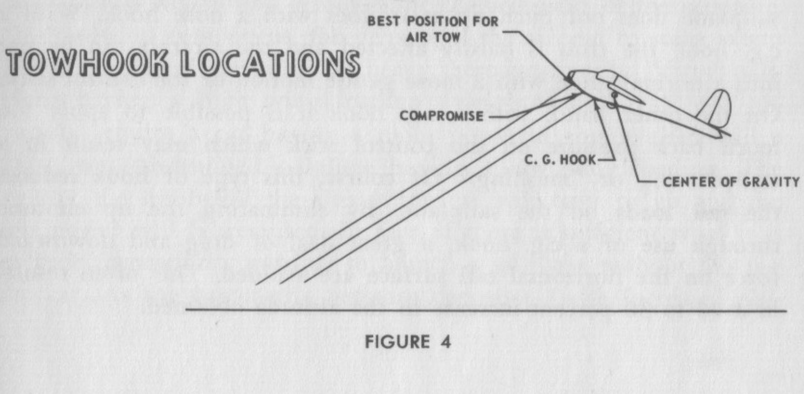


FIGURE 4

In some respects the center of gravity hook is misnamed in that it is not really located at the center of gravity of the sailplane nor does the projected towline go through the c.g. Designers generally prefer to locate the hook in such a position that the pilot is required to carry some back pressure on the control stick so that if he unintentionally releases the control, the nose of the sailplane is automatically pulled down rather than up. If the projected towline passed behind the c.g. the pilot would be required to hold an unnatural forward pressure and if the elevator control were inadvertently released, the sailplane would pitch up dangerously.

With the hook in a position which will make the projected towline pass slightly ahead of the c.g., the tendency for the line to pull the nose down increases as the angle of climb is increased and this automatically tends to limit the angle of climb to that of a safe attitude.

The weak link between the towline and the sailplane is especially important when a c.g. hook is used because an unfortunate combination of poor technique on the part of the pilot and winch operator can easily overstress the sailplane unless the safety link prevents it.

One of the advantages of the c.g. hook, in addition to that of higher launches, is that if the towline or weak link breaks, the sailplane does not pitch up as it does with a nose hook. With a c.g. hook the trim is hardly affected and the aircraft can be put into a normal glide with a more gentle motion of the control stick. On the other hand, with a c.g. hook it is possible to apply too much back pressure on the control stick which may result in a stalled wing or "mushing." Of course, this type of hook reduces the tail loads on the sailplane. By eliminating the up elevator through use of a c.g. hook, a great deal of drag and downward force on the horizontal tail surface are avoided. This often results in a 20 to 30 percent increase in the altitude obtained.

When two tow hooks are installed, one for air tow and one for ground tow, a common release handle should be employed to prevent the pilot's pulling the wrong release. In addition a placard should be painted at the c.g. hook advising the ground crew not to use that hook for air towing.

The advantage of a c.g. tow hook for car tows is illustrated by the fact that with a nose hook, it is generally considered possible to reach altitude equal to 75 to 80 percent of the line length, whereas with a c.g. hook 85 to 90 percent is considered possible. Center of gravity tow hooks are also decidedly advantageous for winch launches.

5a *LAUNCHING BY AUTO TOW*

In launching by automobile, an automobile of at least 150 horsepower is used to pull a sailplane by means of a rope or cable of 500 feet to 2,000 feet (3,000 to 4,000 feet for pulley tows.) Under certain conditions the car tow may be the best or only practical launching method. Car launches to a 1,500-foot altitude are not uncommon. Two methods of car towing, the straight tow and the pulley tow, are in use.

5b *LAUNCHING BY AUTO TOW — The Automobile*

The power required to launch a sailplane by automobile depends on the gross weight and aerodynamic characteristics of the sailplane, the headwind component, the density of the air and to some extent the technique of the pilot. A heavy, aerodynamically "dirty" sailplane having a high wing loading (weight/wing area) will obviously require a car having a more powerful engine than will a light, well-streamlined sailplane having a low wing loading. The greater the headwind the slower the car will have to go and the less power will be required. In fact, if there is sufficient wind it is at least theoretically possible to launch a sailplane without moving the car. As the barometric pressure decreases (with increased altitude of launching site) or the temperature increases, the density of the air decreases. It can be shown that with decreasing density the power required by the sailplane increases and the power available from the automobile engine decreases, thus making a more powerful automobile a requirement at high altitudes. Runway conditions are important also. For example, a soft runway of deep grass will require more power than will a hard surface runway.

With a few exceptions, unless an operation is being carried on at high altitudes, any modern American full-size automobile in good condition can be used successfully for launching a modern single- or two-place sailplane. More will be said on power requirements later in this chapter.

While a standard gear shift can be used by a good and careful driver, automatic shifts, using hydraulic couplings, are so advantageous and available that they might be classed as necessary.

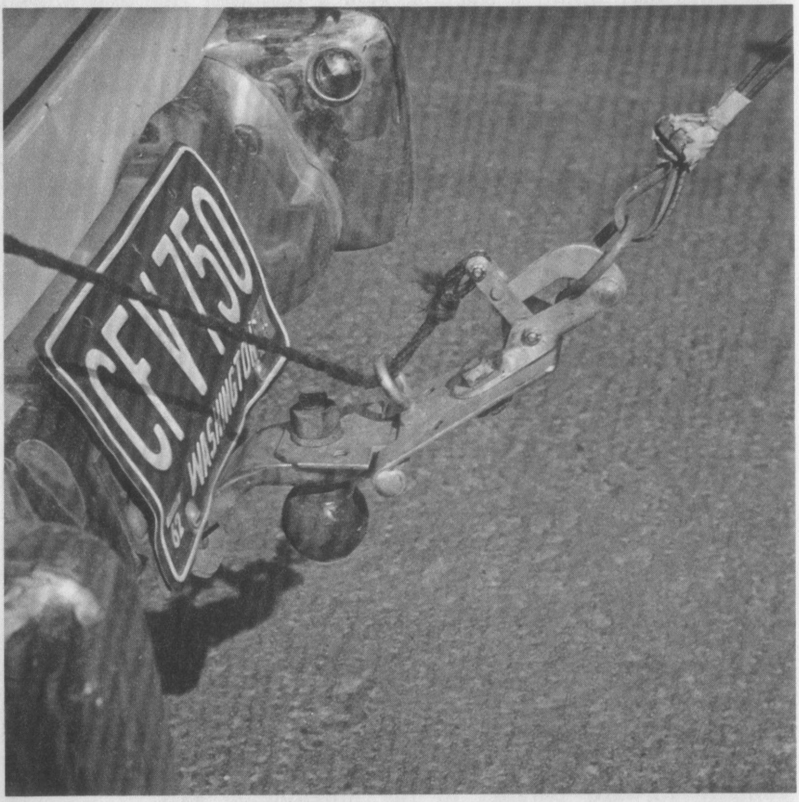
Although the situation is not usually dangerous, the sailplane pilot would naturally prefer not to have the car or the towline fail during the launching. For this reason only automobiles in good condition, and good equipment should be used. It is worthwhile to take such precautions as guarding against running out of fuel or overheating during a tow and insuring that the tow cable is in good condition.

A convertible-top car is to be preferred over a sedan or station wagon because, with the top down, it is easy to observe the sailplane during the launch. If the automobile has a solid roof, it is necessary to carry one or two observers or an adequate system of mirrors to insure continuous observation during the tow. Observers should be experienced enough in car launching technique to be able to recognize it if the sailplane gets into trouble and to interpret all signals. They should be able to give prompt corrective instructions to the driver and know when and how to release the tow cable if it becomes necessary.

Although modern automobiles are usually heavy enough to get good traction without it, there are times when putting weights such as sandbags in the trunk of the car and reducing the tire pressures may improve traction, give a smoother ride and prevent cutting tire tracks in the ground.

A suitable releasable hook should be attached to the rear of the car, mounted in a manner similar to that of a trailer hitch. In fact, a good trailer hitch with the ball removed is ideal for mounting the hook. Although a satisfactory hook can be made or purchased as government surplus, a completely satisfactory hook, the R-100, is available from the Schweizer Aircraft Co. at a reasonable price and is highly recommended. The same hook can be used for ground handling or car tow and it sells for less than $10. This hook may be bolted to the trailer hitch by means of a ½-inch diameter aircraft bolt with castle nut. For a better installation the hook is bolted to a strap hinge and the other end of the hinge is bolted where the trailer ball is normally attached. This permits the hook to move up and down, thus making it easier to free the cable in an emergency. The nut should be drawn up tight enough to be snug, but, in order to reduce off-center stress on the hook, should be loose enough to allow the hook to pivot as the sailplane drifts to right or left.

A completely dependable system for releasing the wire or rope from the car in case the sailplane pilot cannot release it is an absolute necessity. Such a system can be made by running a ¼-inch nylon rope (or suitable substitute) from the release of the hook horizontally forward parallel to the longitudinal axis of the car, through a rugged aircraft pulley, and then to the driver by means of more pulleys or tubes in such a manner that the rope or wire cannot be snagged. The release rope or wire should be located in such a way that the driver can pull it with great strength without danger of making the system fail, so that the driver can surely release the tow cable under any conditions. As an alternative, means can be provided for the observer to release the towline.



A good way of mounting a Schweizer quick release hook so that driver or observer can release by pulling rope.

A useful accessory which will improve the performance and safety of car towing is a tensiometer. The purpose of this device is to indicate the tension in the cable so that the cable is not broken or the sailplane overstressed and to insure that the car is pulling hard enough to avoid stalling the sailplane.*

A pitot-static air speed system similar to those used in aircraft and arranged so that the driver can determine the air speed of the car is a very valuable accessory. The pitot and static tubes should be mounted in the airstream in such a way that they meet undisturbed air. They can be mounted on a strut which is either permanently mounted on the fender, hood or roof of the car or held in place by means of suction cups. The two pressure lines should run to a conveniently observable air speed indicator.

It must be remembered that, because of wind speed gradient and the radial climb path the sailplane is making, the sailplane air speed will exceed car air speed if the launch is being made into the wind.

5c *LAUNCHING BY AUTO TOW—Choosing an Auto Tow Site*

If airport runways of 3,500 feet or greater are available in line with prevailing winds, if the powerplane traffic is not too heavy or sensitive, and if the airport manager will permit it, an airport is probably the best site to use for auto towing because it offers ready-made repair facilities, rest rooms, shelter and often a most welcome cafe or restaurant for the convenience of participants and spectators. However, if for some reason the airport cannot be used, there is no need to despair, for a car-tow gliderport is not difficult to make if suitable fairly level land is available. By means of a scraper, straight, smooth roads suitable for automobile speeds up to 60 miles per hour can be produced. These roads should be aligned with prevailing winds like runways of an airport, should

*Otto Zauner and Art Heavener, "The Elimination of Guess Work During Auto-Towing," *Soaring,* May-June 1955. This article explains how to build and use a tensiometer for auto tow.

be at least 15 feet wide, should be as smooth and level as possible, and should be straight or involve only gradual curving. One should be able to drive at speeds up to 55 miles per hour without discomfort or apprehension, and the longer the roads the better. Approaches at each end of these "runways" should be clear of obstructions and, if possible, should be fields suitable for forced landings. The site should be sufficiently far from other airports to avoid interference and there should be no power lines around to present the possibility of a tow wire's falling across wires carrying current. One or more wind socks should be erected for the convenience of the pilots. Some means of keeping spectators and their cars off the runway is a necessity.

Oiling to stabilize the road and keep down dust is desirable, for it will enable the operation to continue when wet or dusty conditions would otherwise dictate postponement of launching. The shoulders along the runways should be smoothed sufficiently to permit a pilot to land on the runway and allow the wing skid to touch down on the shoulder as the sailplane comes to a stop, without damaging the wing or causing the aircraft to swerve to one side in a ground loop.

If many sailplanes are to be using the strip it is a good idea to prepare taxi strips for taxiing the sailplanes back without interfering with take-offs or landing. High-speed turn-offs are also useful in reducing traffic problems.

5d *LAUNCHING BY AUTO TOW—Tow Wire or Rope*

The length of wire or rope used depends on the length of runway and the height which is to be gained. Usually it is desirable to have at least enough altitude to make a 360-degree pattern for landing from point of release. Such a pattern gets the sailplane back to take-off position with a minimum of ground handling and makes a pleasant flight. While a 360-degree pattern can be accomplished in most sailplanes with less altitude, 600 feet of altitude or more is comfortable and should be sought as a minimum. Auto tows can be made to as high as 1500 feet and many exciting soaring flights have been started with an automobile launch.

Under no-wind conditions short wires can be used to make two or three short flights down the runway and two or three short flights back to start position, thus giving a student take-off and landing training. In order to get 600 feet of altitude a wire or rope of at least 1000 feet must be used. The length of wire chosen is a compromise because if it is too short the maximum height is unduly limited while if too long, the length of car movement is limited and the weight of the wire becomes significant in limiting the height. A straight car tow with less than 3500 feet of runway will usually be marginal or too short for a 360-degree pattern unless there is a strong wind. By experiment it is possible to determine the best length of cable for prevailing conditions of wind, runway length and sailplane weight.

With a strong wind the car need not go so fast; hence it is not necessary to use as much runway in accelerating. Thus a longer cable may be used and the height of launch increased. On the other hand, under calm conditions the maximum possible height is reduced and it will take more runway to get the car up to the required speed. Hence a shorter cable will probably give the optimum height.

While rope can be used as a tow line, it is not as good as wire or cable because of the continuous abusive abrasion which occurs as the tow line is pulled during the launch and while it is being towed back to starting position. Rope does have the advantage of not requiring a drag chute. The use of rope is not recommended unless only a few car tows are to be made.

While hard wire (1/8-inch diameter) can be and is used, it is far from good. It tends to kink and snarl after being dropped, it breaks easily, especially at places where it has been bent sharply, it is difficult to repair when broken, and it is nearly impossible to roll up for indoor storage. It has the advantage of having low aerodynamic resistance, of being inexpensive and of being readily available. Stranded cable is much more satisfactory, but is more expensive and strands of it break in a relatively short time because of abrasion.

The best thing to use for towing by automobile is ⅛-inch diameter tow target cable used by the Air Force to pull aerial targets through the air. Such cable is expensive to buy new, but used cable can sometimes be bought from surplus stores for a very low price. Since surplus cable is used cable, it is more pliable and easier to handle than new cable. This cable is made up of steel strands with a ⅛-inch wide spiral strip covering of stainless steel. The spiral covering protects the stranded cable from wear due to abrasion. The cable stands up well in weather and can be cut with a bolt cutter, fence pliers or cold chisel. Breaks, which seldom occur, can be repaired by cutting the ends neatly, overlapping the ends by 8 inches and securing with 3 nicopress sleeves, one at the center and one at each end. This cable does not snarl or kink when properly used. Hence it is ideal for auto towing. One of the cables which have ideal characteristics for car or winch launching has the following information on the metal identification tag which is nailed to the wooden spool:

Cable, tow target, armored steel
Spec. Mil-C-5765
Size ⅛″ (0.125 - 0.130) Nom. Diam.
Stock No. AF 6500 - 281180
Hackensack Cable Corp. M.O. 11622

Another source of tow target cable is: American Chain and Cable Co., Inc., Automotive & Aircraft Division, 601 Stephenson Building, Detroit 2, Michigan. Order RA-1784, ⅛″ 1x19 tow target, Armored Strand to Mil-C-5765.

Additional information on wire and cable can be found in Chapter 8 of this handbook.

When wire or cable is used for auto towing, a drag chute must be used.* Swivel links are incorporated to reduce twisting and swing links are employed to make detachment of the drag chute convenient. Squeeze links (chain repair links) are used to make semi-permanent connections. These are available at hardware or farm stores.

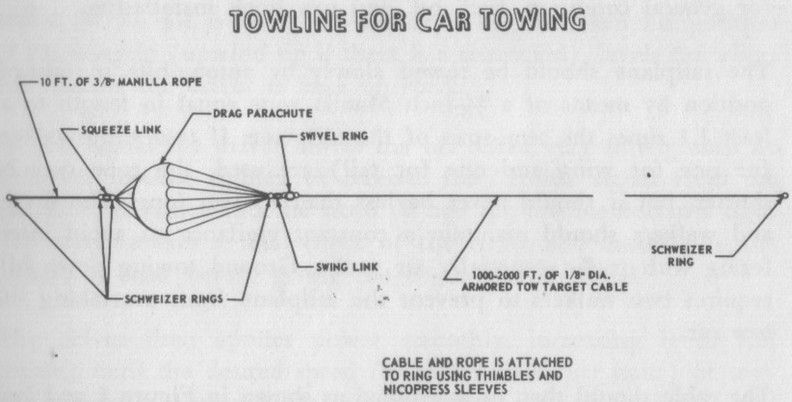


FIGURE 5

6a *LAUNCHING BY AUTO TOW—Auto Launching Procedures*

Two methods of auto launching are used in the United States. By far the simplest and most satisfactory method under proper conditions is straight car tow. In this method the automobile is attached to the sailplane directly by means of the tow line. As the car moves it pulls the sailplane behind it until the sailplane takes to the air and climbs. When the road or runway is too rough for the car to travel at the flying speed of the sailplane, a pulley can be put on the car and a pulley tow accomplished using automobile speeds which are only one-half the ground speed of the sailplane.

*Tom Page, "Tow Line Drag Chute," *Soaring,* January-February 1954. An excellent explanation of how to make a drag chute.
McElfish Parachute Service, 2615 Love Field Dr., Dallas, Texas, offers drag parachutes for sale.

6b *LAUNCHING BY AUTO TOW—Straight Auto Tow Procedure*

After the sailplane has been given a careful inspection (see page 13, Chapter 2), the tow cable and drag parachute should be examined for signs of failure and assembled as shown in Figure 5. Repairs should be made prior to using the equipment if something is worn, broken or torn. The automobile should also be inspected for general condition, fuel, oil, and tow hook installation.

The sailplane should be towed slowly by automobile to take-off position by means of a ⅜-inch Manila rope equal in length to at least 1.1 times the semi-span of the sailplane. If two wing walkers (or one for wing and one for tail) are used, the rope may be shorter, but it should never be less than 15 feet long. The driver and walkers should maintain a constant vigilance to avoid interfering with traffic, especially air traffic. Ground towing down hill requires two walkers to prevent the sailplane from overtaking the tow car.

The cable should then be assembled as shown in Figure 5 and laid out along the runway at the take-off position. Launches should be made into the wind as much as possible.

While one wing of the sailplane remains on the ground, the pilot or pilots get into the aircraft and fasten seat belts and shoulder harnesses. The rope must never be attached to the sailplane until the pilots are ready for take-off *and* have signaled for hook-up. The ground crewman who hooks up the sailplane (frequently called the starter) should challenge the pilot-in-command to check all controls before connecting the towline.

The car crew should have driven to the upwind end of the cable while the pilots were getting ready. When it appears that the sailplane is about ready for launching, the cable is attached to the car and the emergency release checked for operation prior to final hook-up. After attaching the cable to the car hook, the observer should take a position in the tow car where he can watch the sailplane throughout the launch and release the towline if it becomes necessary.

When the pilot is ready for take-off he signals the starter by the verbal command, "Connect towline." The starter connects the towline and then checks the area and traffic pattern for air and ground traffic. When all is ready the starter, who has taken his position at the wingtip (upwind tip if there is a crosswind), levels the wings and signals the driver to take up slack.

At this signal the driver moves the car ahead very slowly until he feels the towline tighten or receives the "Hold" signal from the sailplane, at which time he stops. When the towline becomes tight the starter makes a final check of the traffic and makes sure the pattern is clear before giving the begin-take-off signal.

The driver then applies power smoothly, increasing it to full throttle until the desired speed (about 55 miles per hour) or towline tension is obtained. He then uses a throttle setting which will maintain the speed or towline tension he desires as he progresses down the roadway. The automobile speed should be one which gives the sailplane an indicated air speed between the speed for minimum sink and maximum L/D, and not more than the never exceed speed specified by the manufacturer for auto-winch tow.

As the sailplane begins to move, the wing runner races along beside the sailplane holding the wing level until he must release it because it is moving too fast. If there is a crosswind, the upwind wing should be released lower than the downwind wing to prevent the wind from getting under the upwind wing before sufficient aileron control is available to the pilot.

With the initial pull the pilot positions the stick to keep the wings level and the nose in a level-flight position as air speed increases. Directional control is not a serious problem because the towline tends to keep the nose pointed in a correct direction. As minimum flying speed is obtained, the pilot should apply *slight* back pressure to become airborne and then level off at a few feet of altitude until safe climbing speed is reached. Then, in order to gain maximum altitude, the nose should be gradually raised to a higher and higher attitude as altitude is gained. The nose must be raised fast enough to give the best climb but not so rapidly that a loss of automobile power or a towline break would leave the pilot in a very steep attitude with low air speed and too little altitude to effect a safe recovery. The increase of back pressure should be smooth, never abrupt, and the maximum climb attitude should not be approached below 100 feet.

In many sailplanes the stick can be held at or near the most aft position without danger if a nose tow hook is used. If a center-of-gravity (c.g.) hook is used (see Figure 4) the stick should not be held so far aft because this procedure could give such a steep climb that it would break the weak link. Or, in the case of an accidental break, the pilot might stall before he could get the nose of the sailplane low enough for a normal glide. The climbing attitude in winch or car launching is unusually steep. Therefore, a pilot's first few launches of this type should be made with an instructor. During a winch or car launch using a nose hook there is little danger of a stall because the downward pull on the nose counterbalances the downward tail force and limits the angle of attack obtainable with full aft elevator control.

During the first part of a ground launch the pilot should be ready to pull the release. While it is advisable to keep a hand near the release, it is not good practice to hold the release-control because a jerky take-off may result in accidental release.

The car driver holds his speed until he runs out of runway. Just in time to get stopped by the end of the runway, the driver smoothly reduces the power to idle, applies the brakes, and turns off the runway. This is the time when the observer must be especially alert.

As the climb continues, the pilot tries to maintain a position over the runway using bank and crab to correct for drift if there is crosswind. This requires some skill because it is impossible for the pilot to see straight down. During the climb, if the air speed gets slower than he desires, the pilot, by rocking his wings positively, signals the problem to the observer, who tells the car driver to speed up. If the speed is too great the pilot should apply alternate rudders in order to yaw or fishtail from side to side. Once again this signal is observed, and the driver is advised to slow down.

Eventually, as the launch progresses, the pilot will notice that the rate of climb decreases to zero, or he may feel the pull of the towline decrease to nothing as the driver takes his foot off the accelerator. In either case this is the time to release.

Release should be accomplished promptly by lowering the nose, flying straight, pulling the release knob and holding it, as air speed is increased, until there is no question that release is accomplished. The extra speed will assist in breaking the weak link if it is necessary.

Back pressure on the control stick should always be relieved before the tow release is pulled, in order to reduce tension in the towline and prevent snapping the wire.

Unlike the release from a tow plane during aero tow, where the pilot makes a climbing turn after release, the pilot, when releasing from a car (or winch), should fly over the car (or winch). This procedure gives the glider tow hitch the opportunity to trip automatically and release the cable if the normal release mechanism fails to function. If for some reason the launch has not produced sufficient altitude for a comfortable pattern to a landing, it may be advisable to forego the procedure of overflying the car in order to make a quick turn and set up a good pattern. The release should be pulled twice before a turn is begun.

As the driver brings the car to a halt on a *pre-designated side* of the runway or the drag chute strikes the ground, the observer in the car should pull his release and let the wire come to rest. Stopping the car on one side of the runway gives the pilot the opportunity to land and roll past the car if it becomes necessary. The car crew then returns to the parachute, disconnects it, puts it in the car, attaches the end of the towline to the car hook by means of a short rope weak link, and drags the cable back to take-off position, all the while watching air traffic to avoid being a hazard.

After release the pilot makes a note of his speed, altitude, position and the wind, and from these determines how much altitude he can safely sacrifice in searching for lift before he must establish a pattern and land. If the terrain and conditions are satisfactory a skillful pilot can land very close to take-off position and the car will arrive at take-off position shortly thereafter with the towline. This makes for a quick flight cycle, and an efficient operation results in about four launches per hour.

During a car launch the driver must adjust his speed to that which will result in the best climbing speed for the sailplane. To tow at the optimum speed is not easy. Because the wind usually varies with height and because the sailplane is flying a curvilinear path, the ground speed registered on the automobile speedometer (or the air speed registered on the air-speed indicator of the car if one has been installed) will not give the air speed of the sailplane. If the air speed is insufficient the sailplane will "mush" and may even stall. If the speed is too high the sailplane is liable to be overstressed. To aid the driver in maintaining the best speed the car tow hook may be mounted by means of a tensiometer. Such a unit can be constructed using an automobile master brake cylinder. See Figure 6.

To get the most out of this meter an operation should select an experienced pilot to make a number of experimental flights, using various pressures to determine what constant pressure gives the best launch. This pressure can be maintained during subsequent launches, regardless of wind, to get good results. Different sailplanes often require different pressures.

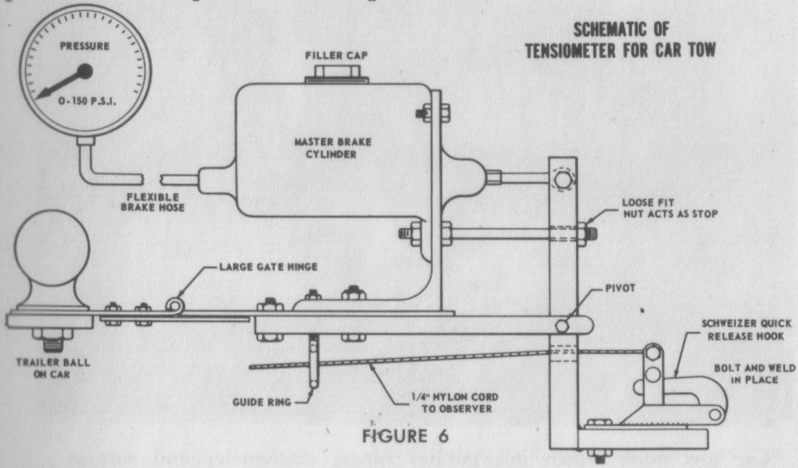


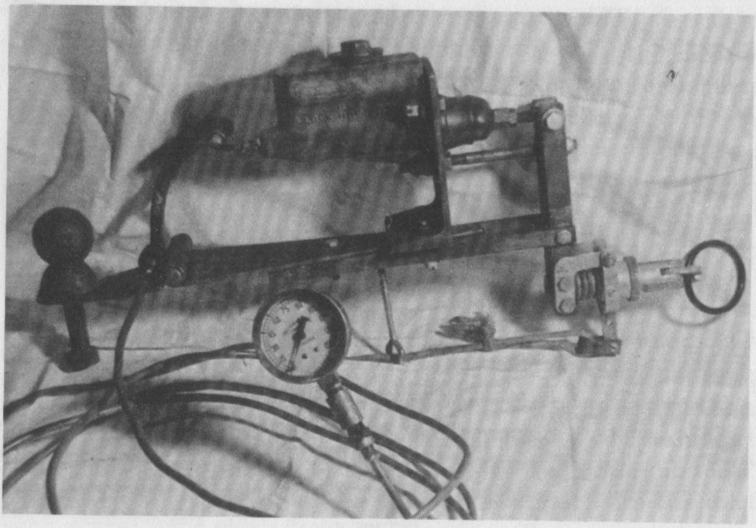
FIGURE 6

6c *LAUNCHING BY AUTO TOW—Auto-Pulley Procedure*

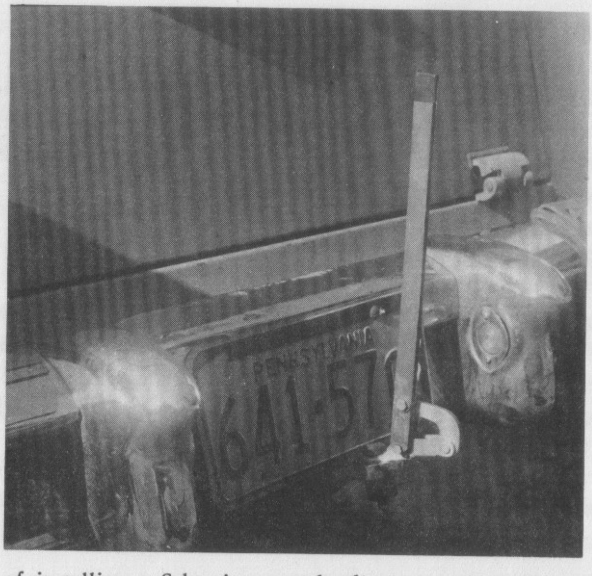
When a 3500-foot or longer smooth runway is not available, a soaring site for a auto-pulley launch may be. During an auto-pulley launch the automobile moves at half the speed necessary for a straight car launch and therefore the driving distance is less and the roadway need not be as smooth. This type of launch will give just as satisfactory launches as straight tow, but the procedure is a little more complicated and slightly more hazardous because of the added complication of the pulley.

To use this method it is necessary to have a trailer ball sturdily attached to the rear of the car. In addition one must have a large steel pulley which can be attached to the trailer ball. These pulleys are available from the Gehrlein Aircraft Co., Thermal-G Gliderport, R.D. 4, Hamot Road, Waterford, Pa. 16441.

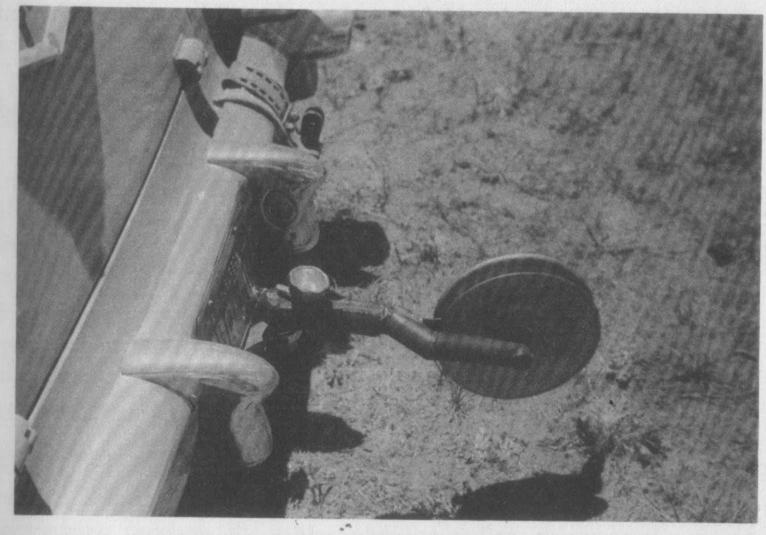
As with the straight auto tow, either rope or wire cable can be used for auto-pulley tow. Tow target cable is ideal. The same safety



Car tow hook which incorporates hinge, tensiometer, and surplus release. Photograph by Ed Byars.



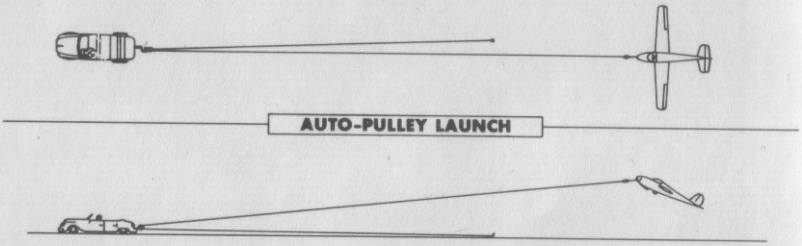
Simple way of installing a Schweizer tow hook on a station wagon.



Pulley used for auto-pulley launches.

Position of observer during car tow using simple installation.

link and parachute should be used at the glider end of the cable as is used for a straight car tow. While 1000 feet of rope or cable will give a very satisfactory straight car launch, a minimum of 3000 feet is necessary for a auto-pulley launch. Figures 7 and 8 illustrate an auto-pulley launch.



FIGURES 7 and 8

This method has a bit more hazard than straight car tow because towline could foul in the pulley. Also, if the pilot cannot release the rope it is more difficult to detach him from the ground by severing the towline. The ideal arrangement would be to have a guillotine at the pulley which could be used to cut the towline and free the sailplane.* In lieu of such a device it is recommended that a safety man be stationed at the stake with orders to cut the line if the sailplane appears to be unable to release. Obviously this man should be experienced in auto-pulley launching. If the cable catches in the pulley this safety precaution will be of little help and it is up to a crewman in the car to get out and cut the cable if necessary.

Pilot procedure and technique are the same as for straight car tows. Automobile driver procedure is similar to that used for a straight tow except that the observer, instead of attaching the cable to the tow hook, loops the cable over the pulley and insures that it remains in place as the slack is taken out of the line. During the launch the observer watches the sailplane and is ready to order

*Barringer's *Flight Without Power* suggests a design for an explosive release.

the driver to stop the car so that he can jump out and cut the towline if it becomes necessary. One bolt cutter or other suitable tool for cutting the line should be positioned at the stake and another carried in a handy place in the car during all launches.

As mentioned before, the driver will use only half the speed he would use for a straight tow. When the car nears the end of the roadway or when further travel would tend to pull the sailplane toward the ground, the driver should reduce power and slow down. When the pilot senses a reduction in power or feels that he is no longer gaining altitude, or notes that the nose of the aircraft is being pulled down, he should nose down to release tension, pull the release and fly over the tow car.

Following release by the pilot the driver continues on for a while to permit the cable to fall without snarling and then stops. The car crew then removes the cable from the pulley, drives to the drag chute, removes the chute keeping the swing link with the chute and then tows that end of the cable back to take-off position where they leave the chute with the starter. They then return to that portion of the cable where it makes the 180 degree turn, put the cable over the pulley and prepare for another launch. A stake placed in the ground at the take-off position can be used to secure that end while the tow car is straightening out the cable in preparation for the next launch.

The main stake located near the starting position of the car must withstand considerable pull and should, therefore, be exceptionally sturdy and securely put into the ground. A car or truck axle, available from any junk dealer, with the bevel gear at one end is ideal in normal soil. Tow target cable can be attached to the stake by using three nicopress sleeves to form a simple loop which is just large enough to go over the bevel gear. If rope is used, the loop should be made by putting an eye splice in the end. If the stake is put in at an angle opposing the pull it will be stronger. Stakes can be put in the ground and if practical left there permanently if flags are placed beside them to show pilots and car drivers the hazard.

This method of launching is suitable over rolling hills provided there are sufficient spots for the sailplane to land in case the towline breaks or the power fails before the sailplane reaches sufficient altitude to make a normal pattern. When the cable must traverse hills, special care must be used in taking up towline slack just prior to the launch.

Location of the main stake is important if maximum height is to be gained during an auto-pulley launch. If the stake is located too near take-off position the maximum altitude is limited by the towline length between the sailplane and the car at the end of its run. A stake placed near the end of the run limits the altitude by limiting the launching run available to the tow car.

7 *LAUNCHING BY AUTO TOW—Notes on Auto Towing*

1. Before a person is permitted to drive the car or act as observer, he should have had considerable experience around the operation and should understand everything that is going on. He should first go along as a passenger in the car and then drive the first few times with an experienced driver sitting beside him to coach him through the launch.
2. There have been instances where static electricity has given participants some bad shocks when metal towline is used. Meteorological conditions which give rise to thunderstorms are worse for electricity, and it is wise to postpone the operation when thunderstorms are quite near. A static line from car to ground, is recommended. This is available at any auto store.
3. Kinks, weak spots, or knots should not be tolerated in the towline.
4. Old tow wires should not be allowed to accumulate around the airport as they are a hazard to aircraft.

5. The factor which determines the towing speed of the automobile is the indicated air speed (IAS) of the sailplane. It has been shown that the launching forces on the sailplane are at a minimum just below the IAS for maximum L/D of the sailplane.

6. NACA Technical Note 753 indicates that the maximum tow forces observed during experiments with auto tow were 1.6 times the gross weight of the sailplane. Porpoising, which may occur near the top of the climb, combines the diving moment created by the wire weight with the elevator stall which can occur when the control stick is held full back. This phenomenon can cause abrupt high loads which give load factors up to about 2.5 if not corrected. A reduction of back pressure will usually correct this situation.

7. During a winch or car launch the pilot should watch his altitude and position and continually change his plan for a forced landing as the launch progresses, and different loss-of-power procedures become appropriate. The time mentally to go to the next landing procedure will depend on wind, landing space available, and pilot skill.

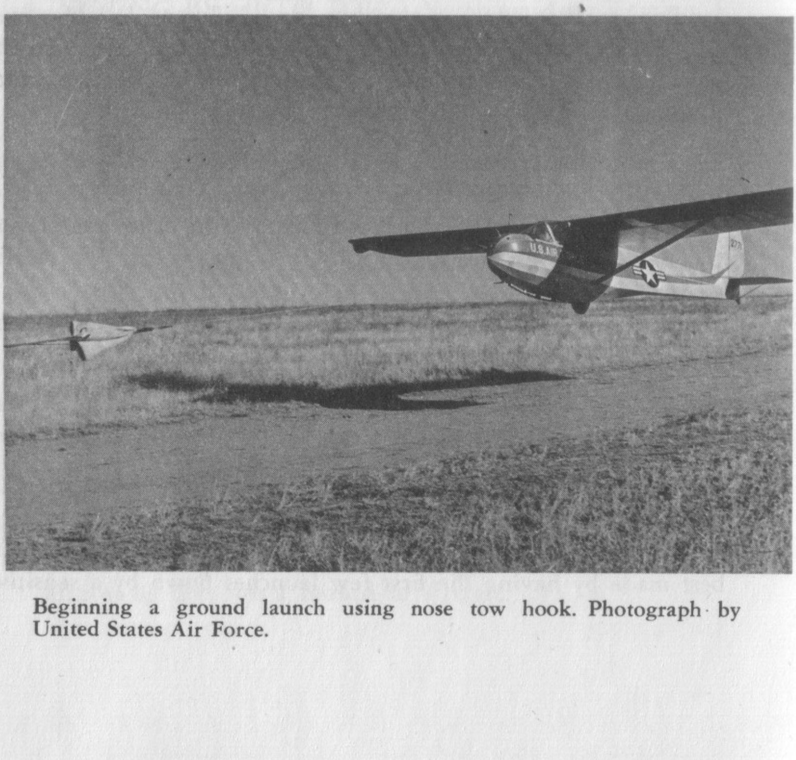
8. Good communications are a big help during a winch or car tow. Walkie-talkie radios using citizens bands are available now at relatively low prices. The ideal setup is to have transceivers for the pilot, observer in the car or at the winch, and starter so that each can hear what is being said. If the visual signals are backed up with radio communications, the operation can be exceptionally safe and efficient.

9. Automobiles with automatic transmissions are so available these days that there is no point in using a manual shift transmission.

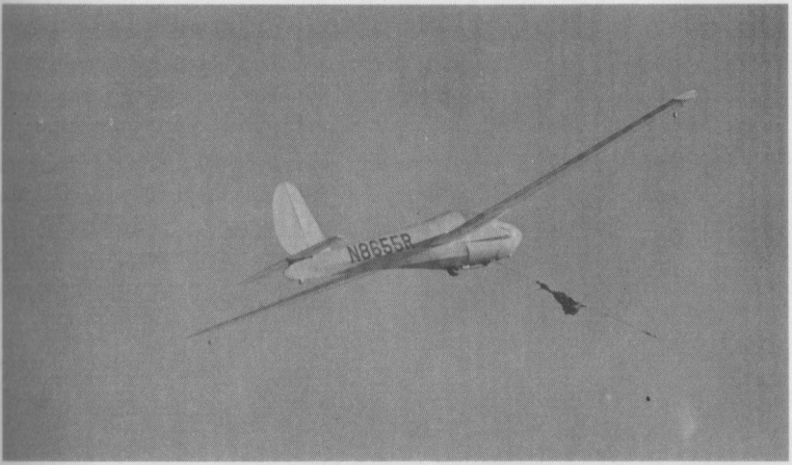
10. If a tensiometer is not utilized during car tows when there is no communication between pilot and observer and there is wind, a judgment of the desirable speed for the tow car is best made by having the first few launches flown by a sensitive

and experienced sailplane pilot using certain agreed-upon ground towing speeds. After these tows the pilot can recommend to the driver what speeds he should use.

11. An auto tow operation should be set up by someone who is experienced in the procedure and who can instruct the driver and pilots well enough to avoid hazardous incidents. Great care must be exercised if there are not numerous places for forced landings beyond the far end of the runway and around the runway. If a club or group has no one with sufficient experience, it is advisable to send an otherwise experienced person to a site where car tows are being used so that he can get instruction and information.
12. Present FAA regulations require a pilot to demonstrate proficiency in ground launches (either car or winch) for a commercial glider pilot certificate.



Beginning a ground launch using nose tow hook. Photograph by United States Air Force.



Schweizer 1-26 during a ground launch using c.g. hook. Photograph by Werner Thanner.

8 *LANDING PATTERNS AND EMERGENCIES*

Landing patterns and emergency procedures used for flights which have been launched by automobile or winch are practically the same and will therefore be treated together here.

Whenever the towline tension ceases, the pilot should immediately lower the nose of the sailplane to increase air speed. Then he should pull the release and establish a landing pattern.

1. *Overrunning the towline*
   If the initial pull of the towline is too hard, the pilot may find that his landing wheel is passing over or ahead of the towline. When this occurs or if the pilot finds he is not ready for flight when the line starts to move, he should pull the tow release knob and abort the take-off. Upon the pilot's release the starter should use a prearranged flag signal to advise the tow car crew or winch operator that the take-off has been aborted and that the launch should be discontinued.

2. *Loss of towline tension below* 300 *feet*
If the power fails or the towline breaks before the sailplane reaches about 300 feet, the pilot should promptly lower the nose of the sailplane, pull the release and land straight ahead.

3. *Loss of towline tension when too high to land straight ahead.*
If tension fails when the altitude is too high or terrain too rough to permit a straight-ahead landing and too low to permit a 180-degree overhead pattern, the pilot should immediately turn crosswind and then into the wind in order to lose altitude. He must be sure to hold an air speed which is higher than the stall speed for the bank being used. Figures 9A and 9B illustrate recommended patterns.

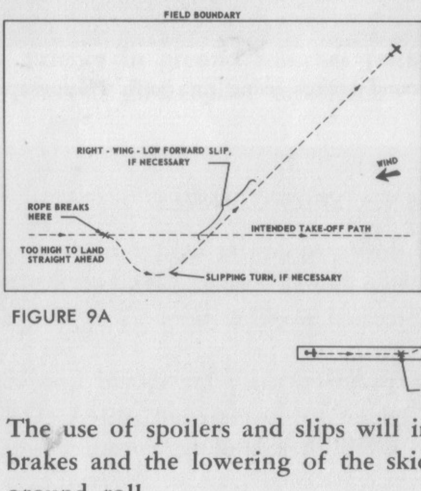
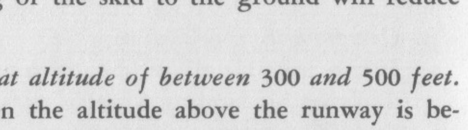


FIGURE 9A

FIGURE 9B



The use of spoilers and slips will increase sink rate, and wheel brakes and the lowering of the skid to the ground will reduce ground roll.

4. *Loss of towline tension at altitude of between* 300 *and* 500 *feet.*
If the tension fails when the altitude above the runway is between 300 and 500 feet, a 180-degree overhead pattern may be accomplished (if a straight-ahead landing is undesirable). Figure 9C illustrates this pattern. If there is a crosswind the first turn should be downwind. When approaching for a downwind landing, one must be careful to maintain air speed above stalling speed but not too much above stalling speed or excessive

Winch launch at Harris Hill, Elmira, N.Y. This was one of the early winches designed and built by members of the M.I.T. Gliding Club. Note the level wind for the rope and the clever drive system. Photograph by Fred T. Loomis.

runway will be used. Normal gliding speed is recommended. If the wind is of significant velocity the pilot will find it impossible to keep the wings level with ailerons toward the end of the landing roll, and the sensation of the wing tip's slamming to the ground is annoying but not dangerous. If other

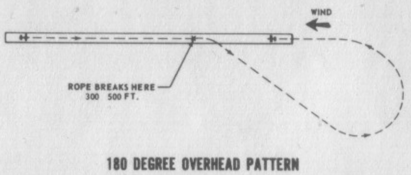


FIGURE 9C

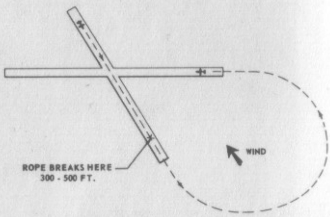


FIGURE 9D

runways or directions for landing are available, it is often preferable to make a 270-degree pattern or something similar and land with a crosswind. The single-wheel gear of a sailplane makes a crosswind landing safe and easy because sufficient bank can be held throughout the landing to compensate for drift. See Figure 9D.

5. *Loss of towline tension when at altitude between* 500 *feet and* 700 *feet.*
   Figure 9E describes a pattern which is recommended when the towline breaks and the sailplane is between 500 and 700 feet. It also illustrates how the base leg can be adjusted to make a landing at a desired spot.

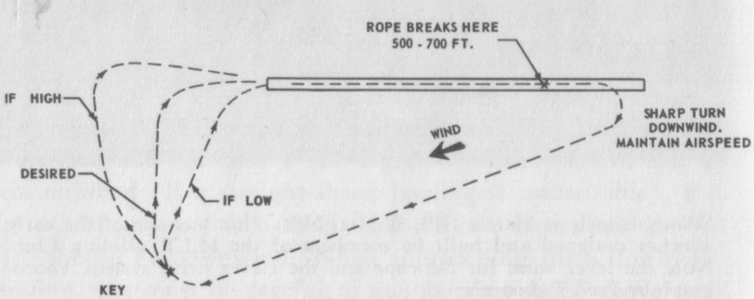


FIGURE 9E

6. *Normal pattern when altitude is* 700 *feet or more.*
The direction of the normal pattern will usually be established by the airport manager. When the pilot has the option of directions and plans to make a rectangular pattern he will do well to turn into a crosswind if he has enough altitude to spend some time searching for lift, and downwind if he has barely enough altitude to make a rectangular pattern. Figures 9F and 9G illustrate these patterns. These rules on pattern flying are

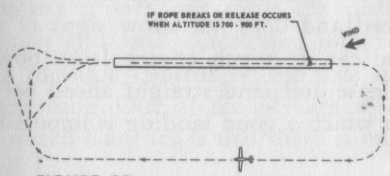


FIGURE 9F

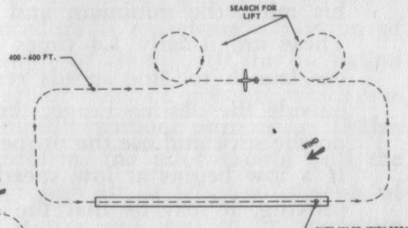


FIGURE 9G

not hard and fast. The best procedure to use (and there may be more than one satisfactory one) will depend on wind, traffic, terrain conditions, the sailplane being used and the skill of the pilot. It may be much safer to land in one of the surrounding fields than to try to make it back to the gliderport. Safety should always take precedence over convenience or pride.

7. *Inability to release towline.*
If for some unexplainable reason the pilot cannot free himself from the towline by pulling the release (still attached to car or winch) an emergency situation exists. The normal way to release under these conditions would be for the pilot to lower his nose and fly over the car or winch at a good speed. The automatic release feature of the tow hook should release. If it does not, the rope will tighten quickly and snap the weak link. If this does not work, the pilot will feel the nose of the sailplane being pulled down. In this case he should immediately go into a steep turn and attempt to circle the car or winch while

the ground crew cuts the line. If this is not accomplished he will have to land with a circular path. If the cable is free of the car or winch but cannot be shed by the sailplane the pilot should plan a pattern which will avoid trees, wires, fences, and other obstacles if possible and make a normal landing.

8. *Overspeeding or underspeeding.*
Before starting a launch the pilot should have firmly fixed in his mind the minimum and maximum speeds he will accept. These are usually 1.4 times the stalling speed, and winch or car launch red-line speeds respectively. If the speed should be outside the desired range, the pilot should relax back pressure on the stick and use the proper signal for a change in tow speed. If a tow begins at low speed and does not show signs of improving, it may be that the car or winch engine lacks power. In this case it is best to release and land straight ahead before getting into a position from which a good landing is impossible.

9 *THE PORPOISING PROBLEM*

During a winch launch or car tow a sailplane can get into pitching oscillations known as "porpoising." This phenomenon usually occurs when the sailplane is nearing the top of the climb. The cause of this unstable situation is the strong downward pull on the nose of the aircraft, which must be counteracted by a downward force on the horizontal tail surface produced by back pressure on the control stick.

With full up elevator (stick back) the angle of attack of the horizontal tail surface becomes so great (negatively) that it stalls, thus reducing the downward force and allowing the sailplane nose to pitch down. This eventually results in a decrease in the angle of attack of the horizontal tail surface, reinstating the downward force which pitches the sailplane nose up. This develops into a cycling situation and the pilot finds his sailplane porpoising. If corrective action is not taken, the problem gets worse. High dynamic loads are imposed on the tow line and sailplane which may cause the weak link to break.

If the pilot attempts to correct by releasing back pressure and then pulling back again against the cycle of pitching oscillation he usually gets in phase with the undulating motion thus aggravating the situation and increasing the porpoising.

The recommended corrective procedure is to release a portion of the back pressure to reduce the angle of climb until the oscillation dampens out, then to add only part of the back pressure which was released, and thus to climb less rapidly without porpoising. If this procedure does not solve the problem, the pilot should pull the release and land. Launching into rough air or jerky movements of the elevator control or too fast a tow can lead to or aggravate porpoising. One of the advantages of using a c.g. hook for ground-powered launches is that there is much less likelihood of porpoising.

Reducing angle of climb by reducing back pressure in the radial travel sector of ground tow climb actually reduces air speed slightly and certainly reduces the air loads on the wing and tail of the sailplane. Reducing back pressure during the climb also reduces the angle of attack of the wings, thus reducing danger of stall.

Thus we see that if a pilot is porpoising, overspeeding, or mushing in a near stall, the corrective procedure is the same; relax back pressure.

10 *CROSSWIND TECHNIQUE DURING GROUND LAUNCHES*

One problem common to car and winch launches is the difficulty of maintaining a path over the roadway or a line between the take-off and winch positions. Crosswinds can be corrected for by bank and crab, but because the sailplane nose is so high, the pilot cannot determine his track very well. Experience will help one to do this, but nothing is as much help as radio communication between the pilot and the winch operator or car observer. The pilot can order speed-up or slow-down; the man on the ground can give orders to correct right or left. If the pilot is unsure of his track, he will do well to try to be upwind if there is a crosswind so that when the drag chute allows the cable to settle on the ground after release it is on the desired track.

Whenever possible, car or winch launches should be conducted directly into the wind. Since this will not always be possible, pilots must learn the technique of launching under crosswind conditions. While some pilots simply ignore drift and others make a stab at correcting for it by yawing with rudder, the preferred procedure is to use a little bank as well as yaw angle. This attitude is not completely comfortable to the pilot, and a skid ball goes to one side under these circumstances. Since the effect of banking becomes less as the launch progresses, becoming zero over the winch, the angle of bank should normally be decreased during the launch.

Beginning a winch launch at the Black Forest Gliderport, Colorado Springs, Colorado. Note c.g. hook. Photograph by Werner Thanner.

Winch launch of a Schweizer 2-22 at the Air Force Academy using a Gehrlein winch. Photograph by United States Air Force.

11a *LAUNCHING BY WINCH*

A winch is nothing more than a large engine-driven fishing reel using steel cable or rope instead of fishline. In using a winch to launch a sailplane, the winch is positioned at the up-wind end of the gliderport and the sailplane is moved to the downwind end. The cable is drawn from the spool and the end is attached to the tow hook of the sailplane. When the take-off signal is given, the cable is reeled in at high speed and the aircraft takes to the air and climbs much as it does during a car launch.

As with car towing, winch launching gives a spectacular take-off and climb because the attitude is so steep. It is not unusual for a sailplane to climb as much as 2000 feet in two minutes when launched by winch, and rates of climb of 2000 feet per minute are frequently experienced with the correct combination of winch, winch operator, sailplane and pilot during the best part of winch launches.

Preparing for a ground launch using a nose hook. Photograph by United States Air Force.

Testing c.g. tow hook release prior to take-off. Note positions of c.g. and nose hooks. Photograph by Werner Thanner.

11b *LAUNCHING BY WINCH—The Winch*

Winches can be purchased on a made-to-order basis in the United States and are available from manufacturers in Europe. The Soaring Society may be able to suggest sources or an advertisement in *Soaring* magazine should enable one to locate a good winch which can be purchased.*

Clubs or individuals may desire to build their own winches. The Soaring Society may be able to suggest sources for plans but if plans are not available when needed, the following information can be used by individuals in designing their own. Visits to sites where winch launching is conducted will give a designer opportunities to examine various designs and learn more of the requirements. There are no government regulations concerning winches, but criteria given here should be met if a safe winch is desired.

Most satisfactory winches provide 3000 to 6000 feet of towline depending on the size and power of the winch and the length of the gliderport for which it was designed. Up to a point the more cable used the higher the launch will be. Too short a towline will make it impossible for the sailplane to reach sufficient altitude to make a comfortable 360-degree pattern. On the other hand, excessive towline (more than 6000 feet) will weigh too much and will result either in overstressing the sailplane or in adding so much weight that total climb is reduced rather than increased.

A satisfactory winch should be well-made and have the following components or characteristics:

1. Chassis
2. Engine
3. Power transmission
4. Drive system

*The Gehrlein Aircraft Co., Thermal-G Gliderport, Waterford, Pa., offers winches for sale.

5. Large spool (reel or drum) containing 3000 to 6000 feet of rope or cable
6. Level-wind mechanism or guide-in features which insure level wind of the towline
7. Guillotine to cut the towline in an emergency
8. Brake for the spool
9. Operator's côntrols
10. Instruments
11. Screened cab for operator

11c *LAUNCHING BY WINCH—The Winch—Chassis*

A winch may be mounted on a truck chassis or built up in the form of a trailer. This unit must be rugged and heavy enough that it does not move when being used to launch a sailplane. If the winch is on the light side it may be necessary to provide anchors, ground stabilizer jacks or chocks.

A winch should be easily portable so that it can be moved from one position to another on the gliderport, or from one gliderport to another. This feature is often overlooked by designers and builders and is sacrificed at times to save money. However, it adds to the convenience and safety if it is easy to move a winch when the wind shifts, and it adds to the pleasure of soaring if the operation can be moved from one site to another. One site might be best for ridge soaring while another is best for thermal soaring. It is great sport to try new places, and farmers will often let soaring pilots use their fields.

Every winch should be provided with a static wire. This may be a heavy copper wire connected from the chassis to a metal stake in the ground or any similar arrangement which will conduct static electricity from the cable to the ground. This will prevent shocks to personnel and reduce the fire hazard.

When a cable breaks under tension it may snap and whip the winch operator. To protect him a well-designed winch will have a cab made of heavy screen of expanded metal used in building construction, which completely surrounds him. Spectators should be cautioned to stay well away from the winch because no protection is provided for them.

11d *LAUNCHING BY WINCH—The Winch—Engine*

While satisfactory launches can be made with less power, a modern automobile engine of 200 horsepower or more should be used to insure ample power for launching most of the sailplanes used in the United States. The engine should be a reliable one, and it should be carefully maintained because it will for all practical purposes be used as an aircraft engine. An electric starter and generator should be provided. The standard radiator that goes with a given engine usually gives adequate cooling, but, if components are being assembled to make a winch, an oversize radiator is recommended. It is important to keep antifreeze in the cooling system so that it does not freeze up during cold periods when the owner is thinking of things other than soaring.

11e *LAUNCHING BY WINCH—The Winch—Transmission*

The modern automatic transmission is so advantageous to winch operation that the manual transmission should not even be considered. The exceptional smoothness of the Buick Dynaflow transmission makes it the number one choice, but any good modern automatic transmission is satisfactory.

11f *LAUNCHING BY WINCH—The Winch—Drive System*

The simplest and least expensive way to build up a winch drive system is to use automobile parts. The shafts and differential of an automobile work very well for transmitting power from the transmission to the drum. This suggests that a good way to start building a winch is to buy a used Buick which has a wrecked body and a good power train. When using an automobile differential it is standard practice to use the right half only. The left axle is not used. This side of the rear housing is cut and a cover is welded over it. It is also necessary to weld the spider gears solid. The automobile rear end can then be mounted to the winch chassis by means of "U" bolts.

11g *LAUNCHING BY WINCH—The Winch—Main Spool*

The spool (drum or reel) design and construction will depend on the type of towline being used (rope, wire or cable), the length of towline, and whether a level wind or a feed-in device is to be used to guide the towline to wrap it on evenly. Even wrapping helps to prevent snarls and snags, which make extending the towline difficult or impossible. If rope is used, the hub of the spool may be of smaller diameter but the spool will have to be wider and deeper than it would be if small diameter cable were used.

A spool for rope can be made by using 30 inches of 12-inch steel pipe as a hub and then welding round $1/4$-inch plates on each end. These plates will have to be of sufficient diameter to hold the desired length of rope. One of the round plates should be drilled to fit to the drive wheel. A stub shaft should be welded to the other end plate and used to support that side of the spool by means of a self-aligning bearing mounted on the chassis. Spools will always have to be balanced as carefully as possible. A static balance is usually sufficient but if means for dynamic balancing are available this should also be done.

While rope, solid wire, flexible cable or tow target cable can be used, tow target cable is so far superior that a designer should not settle for less unless he cannot procure this cable. Identification information for this cable may be found on page 18 of this chapter. It is frequently available through surplus stores.

A spool for using this cable may be made by taking a 6-inch length of 20-inch diameter steel pipe and welding 32-inch diameter round plates of 1/4-inch steel on each end. As with the previously described spool one of these plates should be fitted and drilled for attachment to the drive wheel while a stub shaft is welded to the other plate for an outboard self-aligning bearing.

It is advisable to install a removable cover over the drum to prevent whipping of the cable if it should break near the winch.

11h *LAUNCHING BY WINCH—The Winch—Level Wind*

Unless the rope or cable is wound onto the drum in a level manner it will build up on one end of the spool. Eventually some of these turns, being of larger diameter, will slip to the low part of the spool. The result will be a snarled mess which will hamper the extension of the towline for the next launch and may require hours of work for correction. A good level wind will do much to prevent this problem.

A level wind must be made substantial, especially if it serves to guide the towline as it enters the winch. The simplest level wind is one which consists of a guide for the towline arranged on a sliding mechanism so that it can be moved back and forth across the width of the spool by the operator. More sophisticated winches have automatic level winds which go into action whenever the spool turns. The level wind must be rugged, dependable and easy to use. The parts of the level wind which touch the towline should be rollers of at least 4-inch diameter.

Some designers have had success in eliminating the level wind mechanism by placing main guide rollers at least 10 times the width of the winch drum away from the main drum. In our suggested design the width of the drum is 6 inches. Therefore, the rollers should be at least 60 inches ahead of the drum. The author had an interesting experience with winches when he saw two identical, carefully-designed, well-built winches which used this principle rather than a level wind. One winch was completely successful;

the cable on the other invariably snarled when being drawn out to take-off position. This was because the cable did not wind in a level manner. The only difference between the winches so far as could be determined was that the successful one used old, used tow target cable while the unsuccessful one used new tow target cable. To insure success it is recommended that the winch be provided with:

(a) Guide rollers located at least 10 times the width of the spool in front of the spool

(b) A simple level wind

(c) Well-used tow target cable

The main guide rollers should be at least 4 inches in diameter so that the cable does not wear a groove in them in too short a period and to make it easier for splices in the cable to pass. These rollers should be made of steel and they should be mounted in pairs (two vertical and two horizontal) on ball bearings. To take care of crosswind situations when the cable may angle off from the desired path it is desirable to mount the guides in such a way that they can swivel as a unit.

11i *LAUNCHING BY WINCH—The Winch—Guillotine*

In rare cases the sailplane pilot may find it impossible to release the towline. If he uses proper procedure by lowering the nose and diving over the winch the automatic release should free him or the weak link should break. If the pilot cannot free himself from the towline, he is in grave trouble and must quickly set up a spiral around the winch while the operator cuts the towline.

A satisfactory winch must be provided with a quick-acting, reliable guillotine to do this cutting. A guillotine, as the name suggests, must be a sharp, rugged, cutting blade which will invariably cut the towline the instant the trigger for release is pulled. The blade should either be spring loaded or so weighted and designed that gravity will snap the blade through the towline. Since guillotines must be completely dependable they should be as simple as possible.

One method which has been used is to have a heavy blade mounted on a long heavy arm. When released the arm falls and the blade cuts the towline as it passes over an iron block. It must be remembered that the guillotine must be capable of cutting a moving towline or one at rest and tests should be made to substantiate this capability. Measures must be taken to prevent inadvertent action of the guillotine so that no one loses an arm or hand.

In addition to the guillotine, a safety conscious group will provide the winch operator with an adequate set of wire or bolt cutters which he can use to sever the towline if the guillotine fails.

11j *LAUNCHING BY WINCH—The Winch—Brake*

It is frequently necessary to provide braking action for the spool to keep it from playing out line faster than it is being pulled away and to stop the drum when the drag chute reaches the ground after a launch. Therefore a good winch must have a brake for the spool. While the brake provided on the automobile wheel can be used, it is frequently inadequate and it is recommended that an external braking system be designed. This braking system should be capable of almost instantly stopping the fully loaded spool from a peripheral velocity of 60 miles per hour to a dead stop. This is so the brake can be used to stop the spool if the cable breaks during launch. It should also be capable of maintaining a constant drag force over a long period without overheating so that it can be used continuously while the end of the towline is being pulled to take-off position.

11k *LAUNCHING BY WINCH—The Winch—Controls*

The operator should be provided with controls and switches to operate the following:

1. Ignition
2. Starter

3. Choke (unless automatic)
4. Brake
5. Gear shift
6. Throttle
7. Guillotine
8. Level wind

111 *LAUNCHING BY WINCH—The Winch—Instruments*

The following instruments should be provided in locations which are conveniently observable for the operator:

1. Oil pressure
2. Oil temperature
3. Water temperature
4. Tachometer or speedometer
5. Manifold pressure gage
6. Ammeter

These are all available from automotive supply stores with instructions for installing them.

A highly desirable addition is a tension meter. This instrument which gives an indication of the tension in the towline, adds greatly to the safety of the operation and improves the launching capability of the winch. One way to make such a meter is to install a pulley midway between the guide rollers and the spool or drum so that it pulls the line making it bend from a straight line. As the tension in the line increases that part between the guide rollers and the drum tries to straighten thus increasing the pull on the pulley. If the pulley support is made to actuate a hydraulic piston so that the pressure on the oil is increased as the tension on the cable increases, and a pressure gage is used to measure the hydraulic pressure, the pressure will be in proportion to the tension in the towline. Figure 10 shows schematically how such a meter can be arranged.

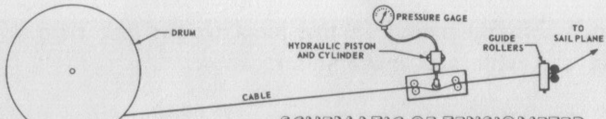


FIGURE 10 SCHEMATIC OF TENSIOMETER FOR A WINCH

This instrument enables the operator to adjust power to keep the tension the same regardless of wind velocity. To calibrate the pressure gage in order to determine the best readings for each sailplane it is recommended that an experienced pilot and winch operator perform a launch using manifold pressure and engine speed while the operator notes the reading on the tension indicator. Then several tows should be made using tension pressures on each side of this reading to determine the optimum reading. This optimum reading can then be used from then on regardless of wind. Pressures will usually be different for different sailplanes.

12 *LAUNCHING BY WINCH—Repairing Broken Towline*

When a rope towline is broken it should be repaired by splicing. It must be remembered that a splice reduces the over-all strength of a rope, but splices are still superior to knots.

If cable is used a bolt cutter (or fence pliers) and a nicopress tool and sleeves are necessary. The cable may be repaired by cutting the ends neatly and connecting them as illustrated in Figure 11.

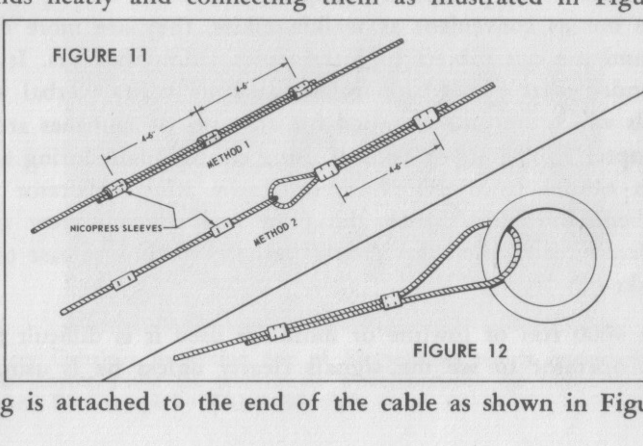


FIGURE 11

FIGURE 12

A ring is attached to the end of the cable as shown in Figure 12.

A ⅛-inch thimble placed in the loop around the ring will reduce wear on the cable and make it last longer.

13 *LAUNCHING BY WINCH—Cost of Winch Launches*

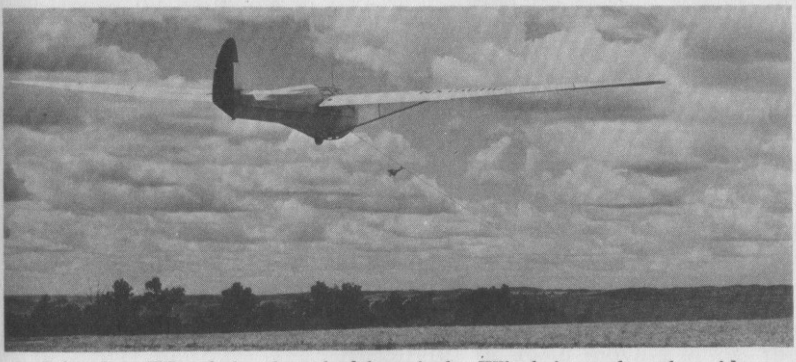
As might be expected, the cost of a winch launch depends on a number of factors, especially the number of launches made per year. If the winch is used to make 200 to 300 launches per year, \$.75 to \$1.25 per launch should cover all the costs. This is about one-third the cost of an air tow.

14 *LAUNCHING BY WINCH—Communication and Signalling*

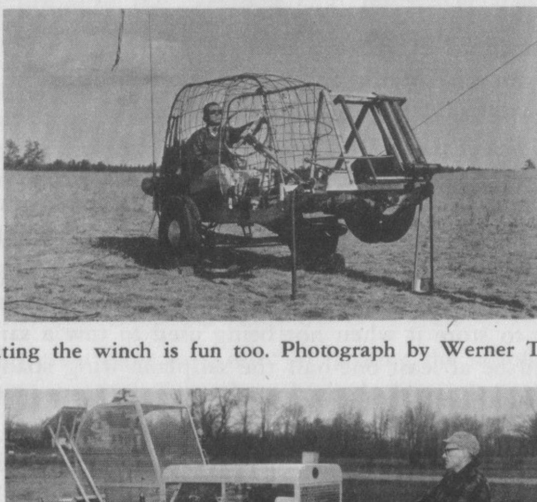
A means of verbal communication between the winch operator and the starter at the sailplane is very useful; communication between these, the car drivers and the pilot is ideal. With the availability of inexpensive "walkie-talkies" using citizen band frequencies, it should be practical for any operation to have one transceiver for the winch operator and one for the starter. Radio communication between the winch operator and the pilot will make it easier to get proper tow speeds and enable the operator to guide the pilot along the correct path.

When the radios are not available it may be possible to install field telephones. These phones are frequently available at surplus stores. While not as convenient as walkie-talkies, they are more dependable and are not subject to interference from outsiders. It is recommended that visual signals be used to verify verbal signals. Signals which are recommended for all types of launches are given in Chapter 2. The importance of using clear signals during a winch launch cannot be overemphasized. If the winch operator should ever begin a launch when the pilot and starting crew are not *completely* ready, the pilot should pull the towline release to abort the take-off.

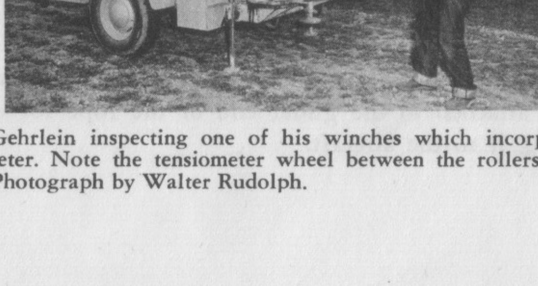
When 4000 feet of towline or more are used it is difficult for the winch operator to see the signals clearly unless he is using field



Schweizer TG-2 being launched by winch. Winch is on the other side of the hill, out of sight. Photograph by Fred T. Loomis.



Operating the winch is fun too. Photograph by Werner Thanner.



Larry Gehrlein inspecting one of his winches which incorporates a tensiometer. Note the tensiometer wheel between the rollers and the drum. Photograph by Walter Rudolph.

glasses. When field glasses are used the operator must be careful to watch for last-minute cancellation of the take-off signal.

It is feasible to have the winch located out of sight of the sailplane pilot or starter. When this is the situation it is especially advisable to have verbal communication, and a method of repeating visual signals at the top of the obstructing hill must be devised.

15 *LAUNCHING BY WINCH—Car Operation*

In order to have an efficient winch operation it is necessary to have at least one automobile and it is preferable to have two unless the sailplanes are making reasonably long flights by soaring.

Primary functions of the car are:
1. Pulling the end of the cable to take-off position.
2. Towing the glider to take-off position.

After the sailplane has been taken out of the hangar, untied, or assembled and inspected, it is ready to be moved to take-off position. Ideally, the car should have a tow hook mounted on it, but a trailer ball or bumper will serve as an attachment point for the tow rope. It is convenient to provide a means for winding the rope on the car to store it when not being used to tow a sailplane. The rope should be at least one-half the sailplane wing span plus about 5 feet in length and should not be so strong that it could overload the sailplane tow hook if the sailplane stops for some reason and the car continues. A $3/8$-inch diameter Manila rope or discarded air tow rope is ideal. A somewhat shorter (say 20-foot) length of rope can be used if sufficient manpower is available to provide two wing walkers so that the sailplane can be prevented from rolling into the car during a downhill tow. A fairly long rope makes it less likely for the sailplane to roll into the car and it provides shock absorption during a rough or jerky tow. A suitable ring should be attached to the glider end of the rope for convenience in attaching it to the aircraft.

To move the sailplane to take-off position the rope is attached to car and sailplane. One person supports a wing tip. If sufficient manpower is available, two wing walkers should be used. When the walkers are ready they give verbal instructions to move out. If there is a crosswind the wing walker should be on the upwind side. The driver should start the car moving very gradually until the slack is taken out of the rope. After this he drives at walking speed, always keeping an eye on the sailplane, listening for instructions from the walkers and watching traffic.

All of the ground crew should be alert for ground and air hazards. The driver must be especially careful to avoid moving across the path of another aircraft or in any way becoming a hazard to air traffic. In bringing the car to a stop the driver must decelerate gradually to prevent the glider from running into the rear of the car.

If only one wing walker is being used and the sailplane begins to overtake the car, it will be necessary for him to lower his wing tip to the ground and hold it back. Meanwhile the driver stops. The result will be that the sailplane turns and comes to rest without colliding with the car. On a windy day it is advisable to tow a sailplane with a person in the cockpit to reduce the possibility of an upset due to the light wing loading of an empty aircraft.

The ground crew must be careful in parking the sailplane and tow car not to obstruct traffic or be a hazard. A sailplane should never

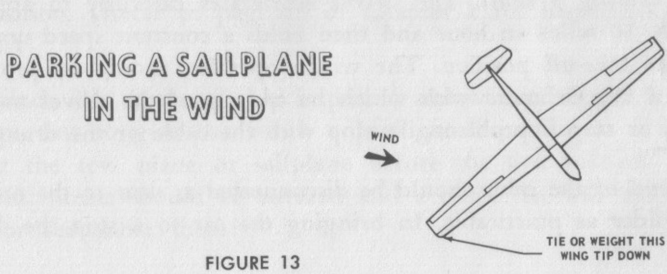


FIGURE 13

be left unattended unless it is suitably tied down or weighted, because a gust of wind might blow it over or otherwise damage it. Sandbags, inner tubes filled with water or tie-down stakes can be used. Figure 13 shows a recommended way to face the sailplane when only one wing is weighted or tied down.

After a sailplane lands it will usually be necessary to return it to the take-off position or parking area. The ground crew may elect to walk the aircraft back (usually by backing it with one or two men supporting the tail and pushing while another walks the wing tip) or, if the distance to go is significant, they may tow it back using the car. The ground crew must be alert and get to the sailplane soon after it stops moving if the wind is strong. They must be careful, however, not to make themselves a hazard to other traffic. High-speed turn-offs, as suggested earlier, provide means for the pilot to clear the runway for the next landing sailplane.

While one ground crew is taking care of the sailplane another assists the winch operator. The end of the winch cable should be attached to the car by means of a weak link of ⅜-inch Manila rope. This rope, which may be of any length, helps to absorb shock and serves to prevent overstressing the cable, winch or car.

To take out the cable the driver, after getting a go-ahead signal from the winch operator, begins to move slowly in a straight line between the winch drum and the take-off position. The winch operator must watch the cable on the drum and maintain a little brake on the drum to keep it from feeding out at too high a rate, thus causing a snarl. The driver accelerates carefully to approximately 10 miles an hour and then holds a constant speed until he reaches take-off position. The winch operator should be provided with a flag or radio with which he can signal the driver to slow down or stop if problems develop with the cable or the drum.

The end of the cable should be disconnected as near to the nose of the glider as practicable. In bringing the car to a stop the driver should decelerate gradually, allowing the drag of the cable to stop the car. The drag parachute and weak link should then be attached to the end of the cable in preparation for the next launch while the driver moves the car to its parking position.

As the launch begins the car should move out behind the glider so as to be near the drag parachute when it strikes the ground. The drag chute and weak link should be disconnected from the cable and placed in the car (keep swing link with chute) and the winch operator signaled to pull in the remaining cable unless the end happens to be on the take-off path or very near it. In this case the cable is attached to the car by means of a weak link and the end returned to take-off position. If the parachute fell far from the take-off path, the cable should be winched in completely and the driver should drive the car to the winch; from here he pulls the cable to take-off position just as was done for the initial launch.

The car used for retrieving the cable should be equipped with wire or bolt cutters, nicopress sleeves, and a nicopress tool as well as other supplies necessary for repairing the towline.

Since this car is required to pull fairly hard for long periods at low speed it must have a good cooling system, and the engine temperature should be monitored continuously by the driver.

16 *LAUNCHING BY WINCH—Inspection*

After the sailplane has been assembled, moved out of the hangar or untied it must be thoroughly inspected and then towed to take-off position. (Refer to page 13 of Chapter 2 for inspection procedure.)

The winch also is thoroughly inspected and warmed up. It is just as important to give the winch a preflight inspection as it is to inspect the tow plane or sailplane before the first take-off. The following items should be covered and a check list will help the operator remember them:

1. Fuel—sufficient amount, drain water from gascolator if possible.
2. Lubrication—check oil supply; apply grease if necessary.
3. Cooling system—radiator full, no leaks, good hose.
4. Static wire—grounded.
5. Spool bearings and brake—free running, brake working.
6. Instruments—operating in the green.
7. Level wind and guides—check for condition and operation.
8. Tension meter—for operation, bleed if necessary.
9. Controls—functioning properly.
10. Guillotine—check and set.
11. Wire cutters, field glasses, flag—in place.
12. Cable—inspected for weak spots or poor repairs. The cable is best inspected by the winch operator as it is slowly drawn out to take-off position by the car.
13. Communication equipment—in place and operating.
14. Drag chute and weak link—inspect, assemble and attach to the tow cable in preparation for making the first launch.
15. Stabilizer jacks or chocks in place.

The winch is usually shut down between launches to save fuel and prevent overheating. The operator can watch the activity at the sailplane through field glasses and know through experience when it is time to start the engine to have it ready when the take-out slack signal is given.

17 *LAUNCHING BY WINCH—The Launch*

When sailplane and winch are ready, the pilot gets into the sailplane, fastens his seat belt and shoulder harness and prepares for take-off. When he is ready to go he signals the starter, who, after checking ground and air traffic, signals the winch operator to take out slack.

The winch operator gradually applies power to start the cable coming in very slowly. When all the slack is out, the cable will slow up sharply or stop and the starter will signal from the take-off position that the slack is out. At this point power is reduced by the winch operator, but enough power to keep the cable taut is maintained.

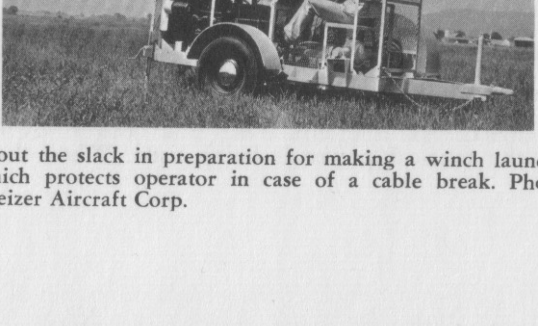
When the starter is certain that the winch operator realizes that the slack is out of the towline, he makes a final check of traffic and the readiness of the pilot and then signals for take-off. Receiving the take-off signal, the winch operator applies power smoothly, rapidly and steadily until the throttle is wide open or until the tension meter, tachometer or drum speedometer shows the value which has been determined to give the best launch. Until the angle between an imaginary line from sailplane to winch and the ground is about 30 degrees, maximum power is used unless it has been determined that the winch has excessive power or the pilot gives a signal that the tow is too fast. If a tension meter is provided, the operator should use a throttle setting which will keep the tension meter reading the desired value.

As the sailplane begins to roll, the pilot should keep the wings level with the ailerons and move the control stick fore and aft to keep the sailplane rolling level as it gathers speed. He should get the aircraft into the air as soon as flying speed is reached by using some back pressure on the stick, but without forcing the take-off. Immediately after leaving the ground the pilot should level the sailplane at an altitude of a few feet until climbing speed is obtained. At climb speed the stick should be pulled back gradually to initiate the climb. At approximately 100 feet of altitude the stick should be pulled back smoothly to the stop (or nearly so) and held there. If a c.g. hook is used on the sailplane, it will not be necessary or advisable to pull back so hard.

When the line between the sailplane and the winch reaches 30 degrees above the ground the operator should gradually and smoothly start reducing power so that when the launch has progressed to the point where the angle is 60 degrees, only about 20 percent of the take-off power is being used. When the angle be-

Keeping in communication during a winch launch.

Modern Gehrlein winch can be purchased for much less than a towplane.



Taking out the slack in preparation for making a winch launch. Note cage which protects operator in case of a cable break. Photograph by Schweizer Aircraft Corp.

comes 70 degrees, the remaining power should be cut sharply to idle in order to signal the pilot to release.

Throughout the climb, using the nose hook of the sailplane, the pilot should hold the stick back to the stop or nearly so, signaling for changes of speed if necessary and maintaining a straight line track from take-off point to winch by crabbing and lowering the upwind wing into a crosswind. When he senses the complete decrease of power or notices that he is no longer gaining altitude, the pilot should reduce back pressure on the stick, thus reducing towline tension, pull the release a couple of times and fly over the winch.

Wind has the same effect as increasing the towline length without the disadvantageous effect of added weight, and therefore will produce higher launches. When towing a sailplane into a wind, the operator must be very careful to avoid overspeeding the sailplane. Wind velocity usually increases with altitude, and this is another reason why engine speed should be reduced as the launch progresses.

If the towline should break during the launch, the pilot should immediately nose down, pull the release and establish the best pattern for the situation. (See Figure 9.)

As the pilot releases the towline the drag chute should open, indicating to the winch operator that release is accomplished. He should immediately apply some power to reel in the cable. The objective at this point is either to have the chute drop on the runway or, if it appears to be drifting, to get as much of the towline on the spool as possible before the chute hits the ground. Just before the chute hits the ground the operator should close the throttle and apply the brake in order to avoid dragging the chute across the ground. If the chute lands on the roadway, the ground crew removes the chute, places it in the car, and then tows the end of the cable back to take-off position. When the chute has drifted to one side of the roadway before striking the ground, the crew removes the chute and signals to have the towline reeled in to the point where the end can be dragged back to take-off position with the towline lying along the roadway.

The reader is referred to the sections on Landing Patterns and Emergencies, The Porpoising Problem, and Crosswind Technique During Ground Launches on pages 33 to 40. These procedures apply to winch launch as well as to auto launch.

18 *LAUNCHING BY WINCH—Characteristics*

Using the laws of physics, mathematical relationships can be developed and plotted as curves to reveal some interesting and useful facts about winch launching. Figures 14 through 18 present some of the characteristics of winch launching. Figure 14 defines the terms which will be used.

Figure 15 shows that the maximum flight path angle for a given load factor can be achieved at the beginning of the tow. This is why the pilot should increase back pressure on the control stick as soon as he is high and fast enough to do it safely. Figure 15 deals with angles instead of distances and is, therefore, applicable for any length of tow. This figure points out how the flight path angle (and thus rate of climb) can be increased by using a higher load factor. The load factor depends, among other things, on the position of the tow hook and the pitching moment which is being created by the up elevator. Moving the tow hook aft toward the line through the center of gravity makes it possible for the pilot to pull a higher load factor with less elevator force. Within the limits set by stability and control requirements for free flight, designers can limit the load factor which can be pulled for a given location of the tow hook by reducing the size or travel of the elevator. Figure 15 shows that as β increases, the flight path angle decreases and after β gets to about 70 degrees, little can be gained by continuing the launch; the pilot is better off to release and start gliding. It should be pointed out that a high load factor makes the wing of the sailplane more susceptible to failure in that it leaves a smaller margin of safety to withstand sudden increases in lift due to gusts. For a given sailplane the load factor may be increased by pulling back harder on the elevator control or by increasing the speed through increased power to the winch.

The curve shows that angle of climb can be increased considerably by increasing the load factor from 1.5 to 2, but that there is only a small benefit in going from a load factor of 3 to one of 4.

Figure 16 shows that the tension on the towline is normally greatest at the beginning of the launch and that it gradually decreases as the sailplane approaches the winch (or car for auto tow).

It can be shown that a safety link which will withstand tension equal to twice the weight of the sailplane will be satisfactory and will prevent the pilot from overstressing the wings of a properly designed sailplane.

The winch operator will have to apply most of the power available at the beginning of the tow in order to get the high speed required at low β as shown in Figure 17, and the high torque as shown in Figure 16. As the launch progresses it is desirable to maintain a fairly constant air speed which is well above stall speed but less than red line speed for a ground launch. To do this the speed and torque are gradually reduced, after β exceeds 30 degrees, by a gradual and smooth closing of the throttle. Prior to beginning the launch the operator should estimate what proportion of the total available power he will want to use. Light, clean sailplanes will use less power than large, heavy ones. Power required will also decrease with increasing headwind component. Another factor which will influence the power the operator should use initially is the load factor he expects the pilot to pull. A pilot who pulls a high load factor because he has an effective elevator or a c.g. hook will need more power than one who has a hook in the nose of the glider and a small ineffective elevator.

In applying the highest power he has estimated he will need, the winch operator should open the throttle smoothly and rapidly. As the launch progresses he should keep the towline cable or drum speed nearly constant until β equals about 30 degrees, and then start reducing power to reduce tension and engine speed until β, equals about 60 degrees, where about 20 percent power is being used. At between $\beta = 60°$ and $\beta = 70°$ the throttle should be closed completely to signal the pilot to release.

The operator should observe the sailplane throughout the launch. If the aircraft does not appear to be climbing as it should, he should add power and watch for a signal from the pilot. If it seems to be climbing at too steep an angle the operator should watch for a signal to reduce power.

In estimating the stalling speed of the sailplane during a winch or car launch, one must consider the weight of the cable and tension in it. The stalling speed increases directly with the square root of the load factor. Thus a sailplane which stalls normally (in one-g flight) at 30 miles per hour will stall at $30 \times \sqrt{2} = 42.5$ miles per hour during a launch using a load factor of 2.

Figure 18 shows how the altitude gained will be a function of the load factor, β, and towline length for the sailplane analyzed by Lipstein* under no-wind conditions. Up to a point, a longer towline will give higher launches, as shown in the figure. However, if the line is too long the added weight of the cable reduces the climb and a point of diminishing return is reached. The author has used 5000 feet of armored tow target cable to get excellent launches when launching from a ground elevation of 5500 feet above sea level.

*Figures 14 through 18 are based on information from "Winch Towing Fundamentals" by Norman J. Lipstein, *Soaring*, July-August 1954.

FORCES ACTING ON A GLIDER DURING TOW

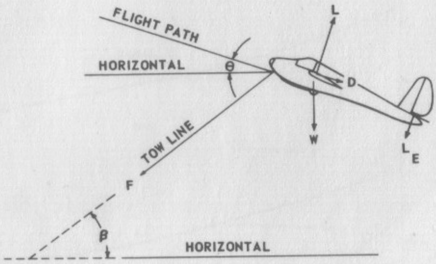


FIGURE 14

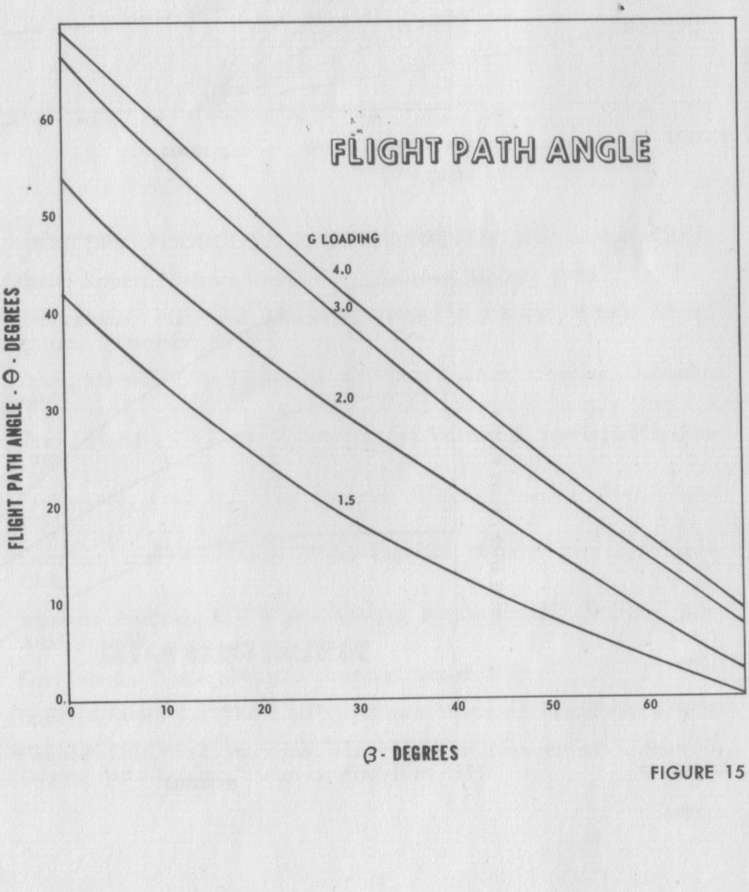


FIGURE 15

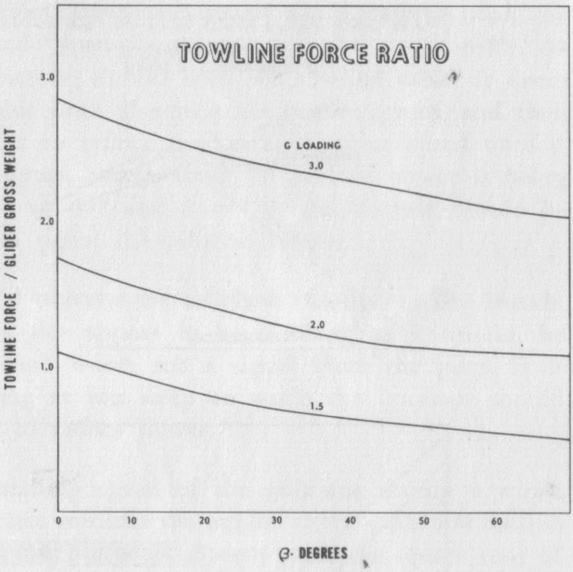


FIGURE 16

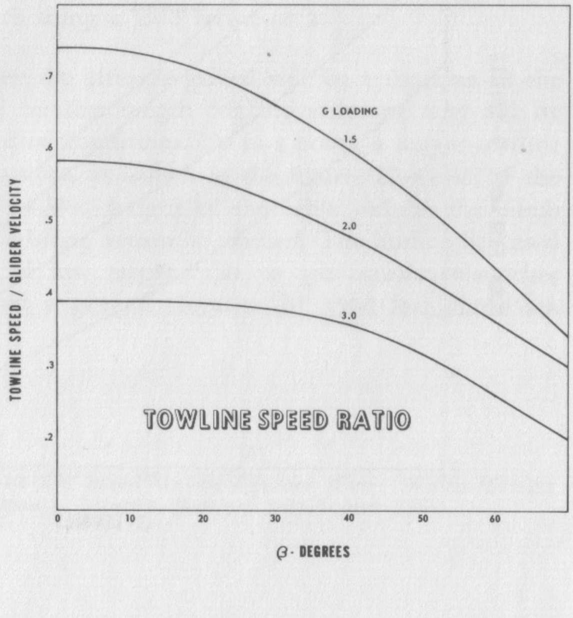


FIGURE 17

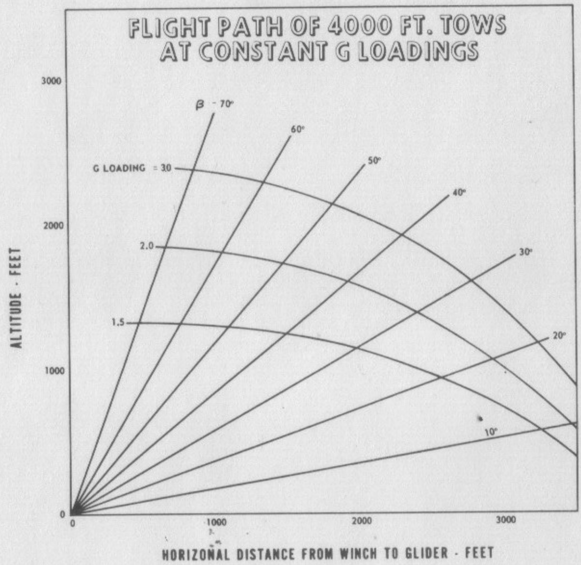


FIGURE 18

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