AEROBATICS

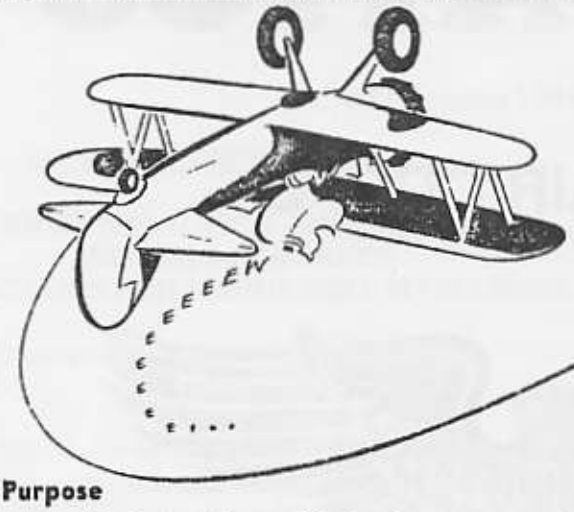
U.S. ARMY AIR CORPS

Reprinted from:

PRIMARY FLYING

Prepared by the
ARMY AIR FORCES TRAINING COMMAND
VISUAL TRAINING DEPARTMENT
in collaboration with the
CENTRAL INSTRUCTORS' SCHOOL
Randolph Field, Texas
January, 1945

Acrobatic Maneuvers



Adherence to rules and regulations is

Imperative to safety in flying

Regardless of individual ideas.

Discipline in the air means following orders

Instinctively; doing what you are

Supposed to do—when you are told to do it.

Control your desire to "raise cain" with

Indiscriminate flying. Be your own

Policeman!

Listen to advice and direct your enthusiasm

Into the job you have to do.

Negligence and the lack of self restraint

Endanger the lives of all other pilots.

Purpose

Acrobatic training will develop your confidence in yourself as well as in the airplane. It will teach you aggressiveness, relieve you of any doubt about inverted flight, and improve your flying technique generally.

As you become adjusted to acrobatic flying you will think and act as easily upside down as right-side up. Acrobatics are closely related to combat flying. Learn them well.

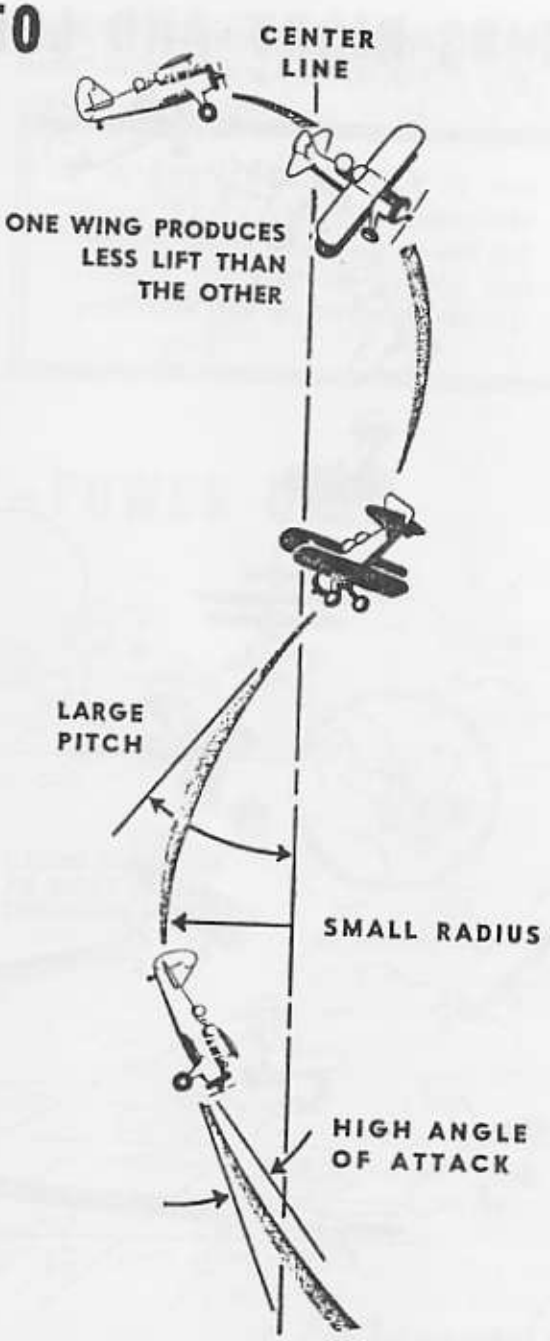
You will find that you need not disregard the fundamentals you have learned thus far in your training. Moreover, you will find no need for brute strength at the controls. Feel is the key to smooth execution of acrobatics.

Acrobatics are fun and you will enjoy doing them, BUT PAY PARTICULAR ATTENTION TO YOUR INSTRUCTOR'S ADVICE. THE LACK OF AIR DISCIPLINE WHILE PERFORMING ACROBATICS EXACTS THE MAXIMUM PENALTY.

NO PORTION OF ANY ACROBATIC MANEUVER WILL BE PERFORMED AT ALTITUDES LESS THAN 1,500 FT. It is desirable, for safety reasons, to start acrobatic maneuvers above 3,000 ft.

The procedures and techniques of execution that follow are designed to teach as much as possible in the time available. Other techniques of executions may produce a better maneuver, but it takes too much time to teach them. Once you understand the fundamentals of acrobatics, you can develop your own technique through practice.

YOUR INTRODUCTION TO *Spins*



If you hold an airplane in a complete stall, without attempting a recovery, a spin may result. **Don't fear spins—respect them.** If you know the proper procedure, the process of recovering from an intentional or unintentional spin is no more difficult than the performance of any other maneuver. BUT YOU MUST LEARN THE PROPER SPIN RECOVERY and practice it until it becomes a natural, automatic series of control movements.

The Why of Spins

The primary trainer must be forced into a spin by deliberately stalling it and manipulating the controls in such a way as to cause a spin. However, you will not find this stability in the faster, tactical airplanes that you will eventually be flying. That is why you must master a definite spin recovery. Never spin a strange airplane until someone tells you how or shows you how.

Aerodynamics of Spins

In a spin an airplane descends along a helical path of large pitch and small radius. One wing must produce less lift than the other, and the angle of attack must be greater than that at which maximum lift is produced.

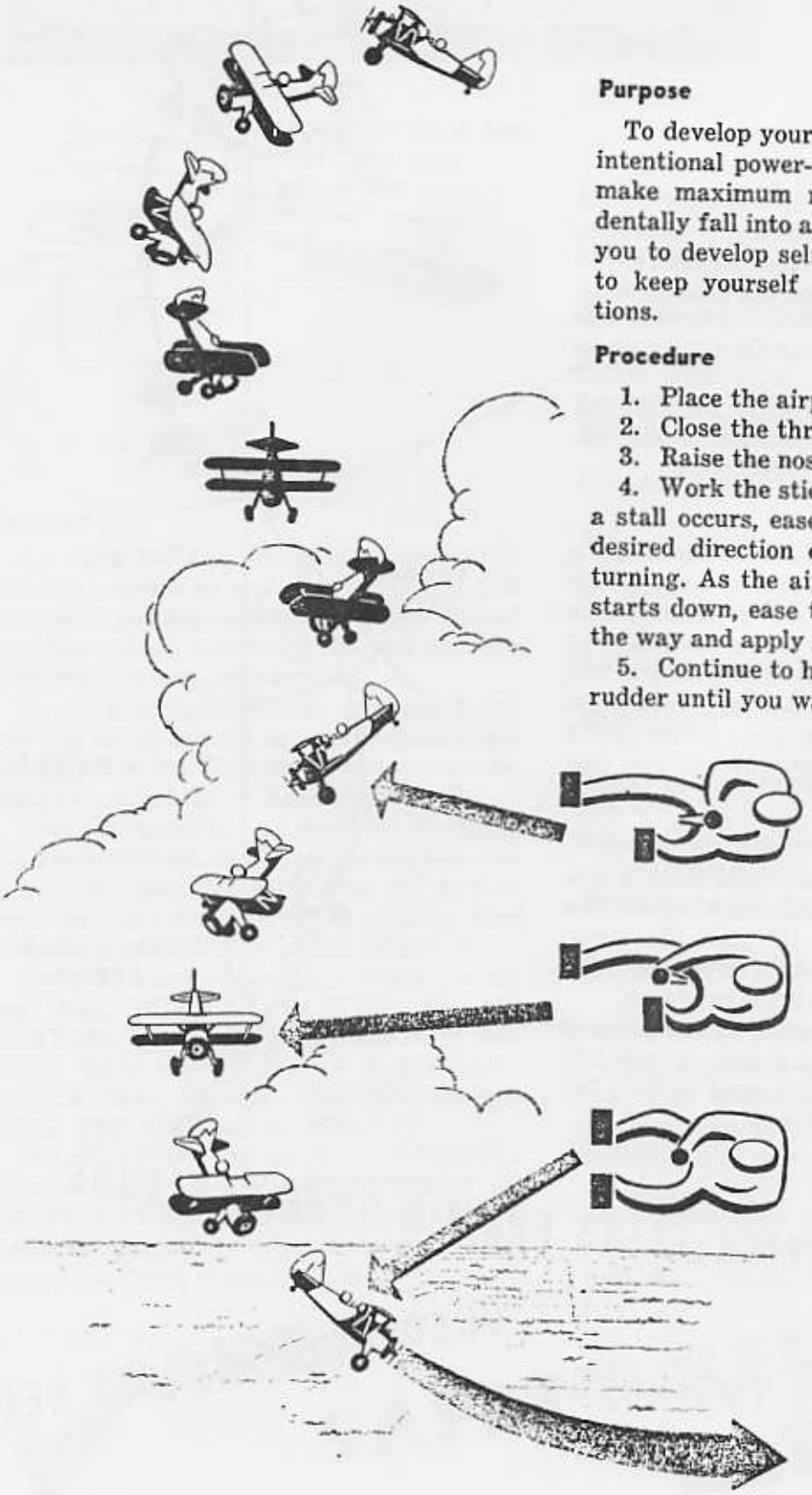
To prolong a spin, the controls of a primary trainer must force the airplane to maintain these conditions. The stick must be held full back and the rudder full on.

ALWAYS PRACTICE SPINS FROM A SAFE ALTITUDE

CHECK YOUR SAFETY BELT

ALWAYS CLEAR THE AREA

SPINS RIGHT AND LEFT—POWER OFF



Purpose

To develop your ability to recover from an intentional power-off spin and enable you to make maximum recovery should you accidentally fall into a power-off spin. It will help you to develop self-confidence and teach you to keep yourself oriented in unusual positions.

Procedure

1. Place the airplane in level flight.
2. Close the throttle.
3. Raise the nose to landing attitude.
4. Work the stick back slowly. Just before a stall occurs, ease on a little rudder in the desired direction of spin to start the nose turning. As the airplane stalls and the nose starts down, ease the stick straight back all the way and apply full rudder.
5. Continue to hold the stick back and full rudder until you want to recover.

Recovery

1. As the nose crosses the desired recovery point apply full opposite rudder.
2. After an additional one-fourth to one-half turn, or until the rate of rotation is reduced, move the stick straight forward with a brisk motion, to a position at least beyond neutral.
3. Positively hold this corrective control until the airplane stops rotating; then neutralize the rudder and fly out of the dive.

Spin recovery should be started at the end of a designated number of turns, such as one, one and a half, or two turns.

NOTE: This spin recovery procedure, a modified version of the NACA spin recovery, is effective in the Primary trainer and most other types of airplanes. Certain airplanes, however — particularly tactical airplanes — have their own individual spin characteristics. In such airplanes you may need special spin recovery techniques. To be safe, always check the **"Pilot's Flight Operating Instructions"** before flying a model new to you.

> A SPIN RECOVERY is one place where slow and cautious movements of the controls are out —move the controls briskly and positively for a normal recovery.

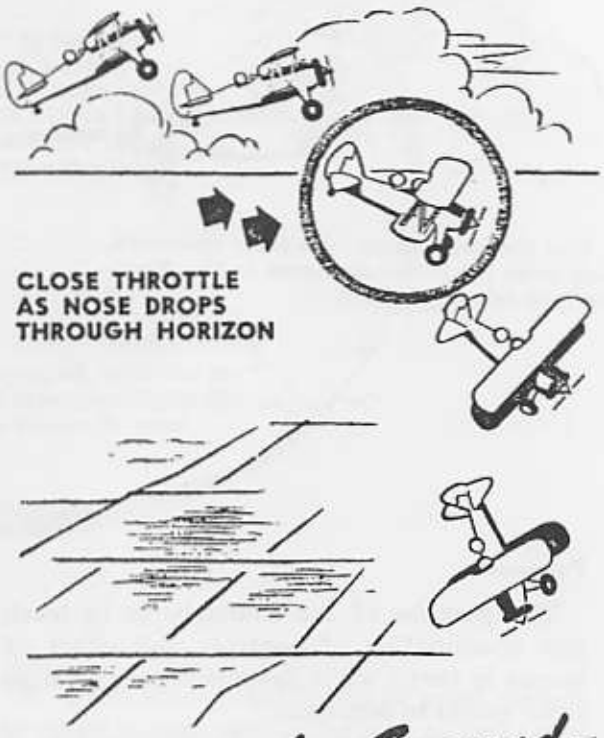
SPINS RIGHT AND LEFT—POWER ON

Purpose

To demonstrate to you that an airplane will spin with the power on, and to develop further your ability to recover from accidental spins.

Procedure

1. Throttle at cruising.
2. Raise the nose to a steep climb straight ahead.
3. Work the stick back slowly. Just before a stall occurs, ease on a little rudder in the desired direction of spin to start the nose turning. As the airplane stalls, and starts to spin, ease the stick straight back all the way and apply full rudder.
4. When the nose has dropped through the horizon, close the throttle. The spin is then the same as a normal power-off spin.



Recovery

Recover in the same manner as in the power-off spin.

DURING THE SPIN *Look Down at the Ground-*

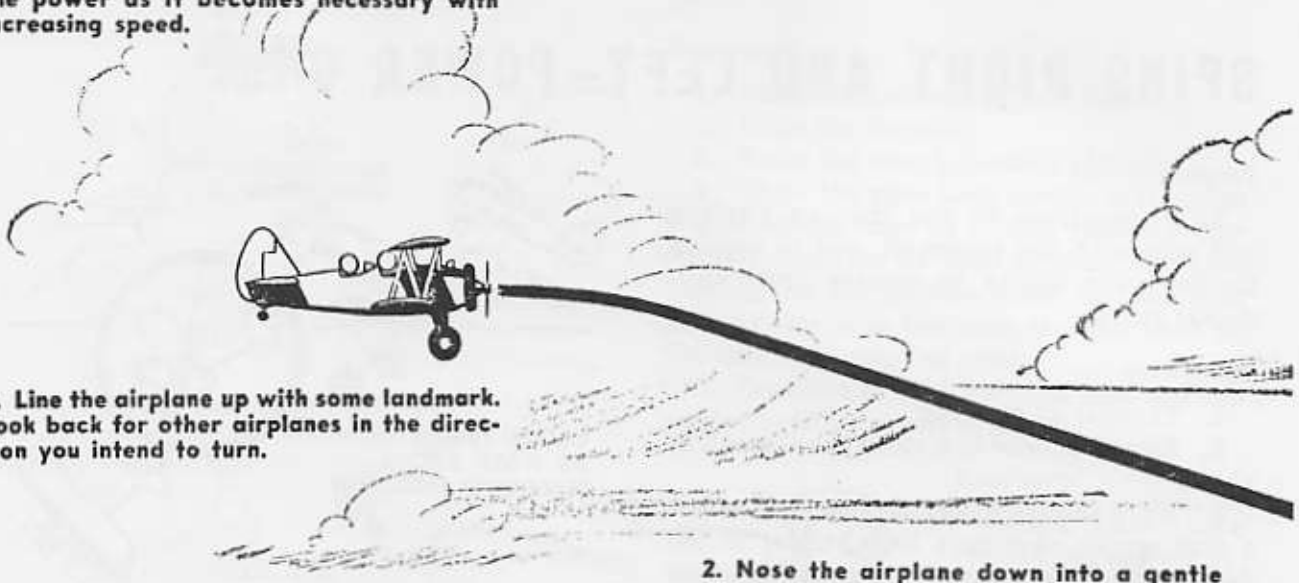
Not at the Horizon

ROTATION WILL APPEAR SLOWER

Chandelle

7. Properly executed, the wings will reach level attitude and the nose its highest angle of climb at the same time and with minimum speed without stalling.

8. Lower the nose to level flight, and reduce the power as it becomes necessary with increasing speed.



1. Line the airplane up with some landmark. Look back for other airplanes in the direction you intend to turn.

2. Nose the airplane down into a gentle dive until you reach 20 to 25 mph above cruising. During the dive do not exceed the maximum allowable rpm.

Purpose

The purpose of the chandelle is to teach you coordination of controls and effect of torque in turns while the speed range varies from excess to minimum.

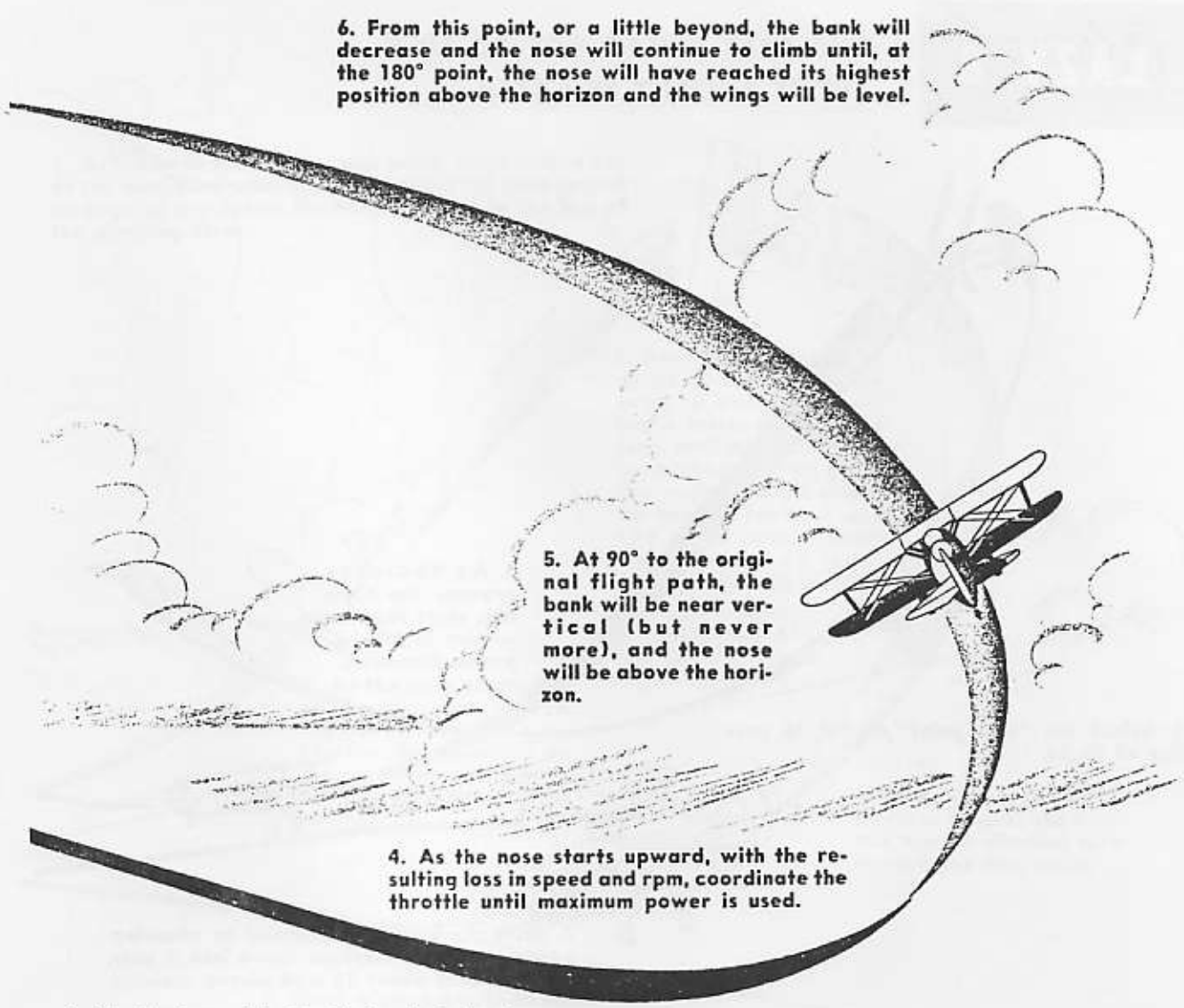
The chandelle consists of a shallow dive, a maximum-performance climbing turn, and a precision roll-out. It is a precision maneuver executed through 180° of turn. There are many types of chandelles, but your first job is to master the standard training chandelle. Use section lines, roads, and other landmarks to aid in making a precision recovery 180° from your original heading.

The perfect pattern for this chandelle requires a constant rate of turn, a constant rise of the nose, carefully timed increase and decrease of bank, and a precision roll-out at the 180° point.

Torque is at its maximum during the roll-out. On recovery from the left turn, more rudder will be required than on recovery from the right turn.

The Most Common Errors Are:

1. Failure to watch for other aircraft.
2. Failure to get enough initial speed.
3. Poor coordination.
4. Poor torque correction.
5. Poor timing.
6. Too rapid or too slow rate of turn.
7. Allowing the airplane to overbank.
8. Inaccuracy of turn.
9. Poor coordination of power.

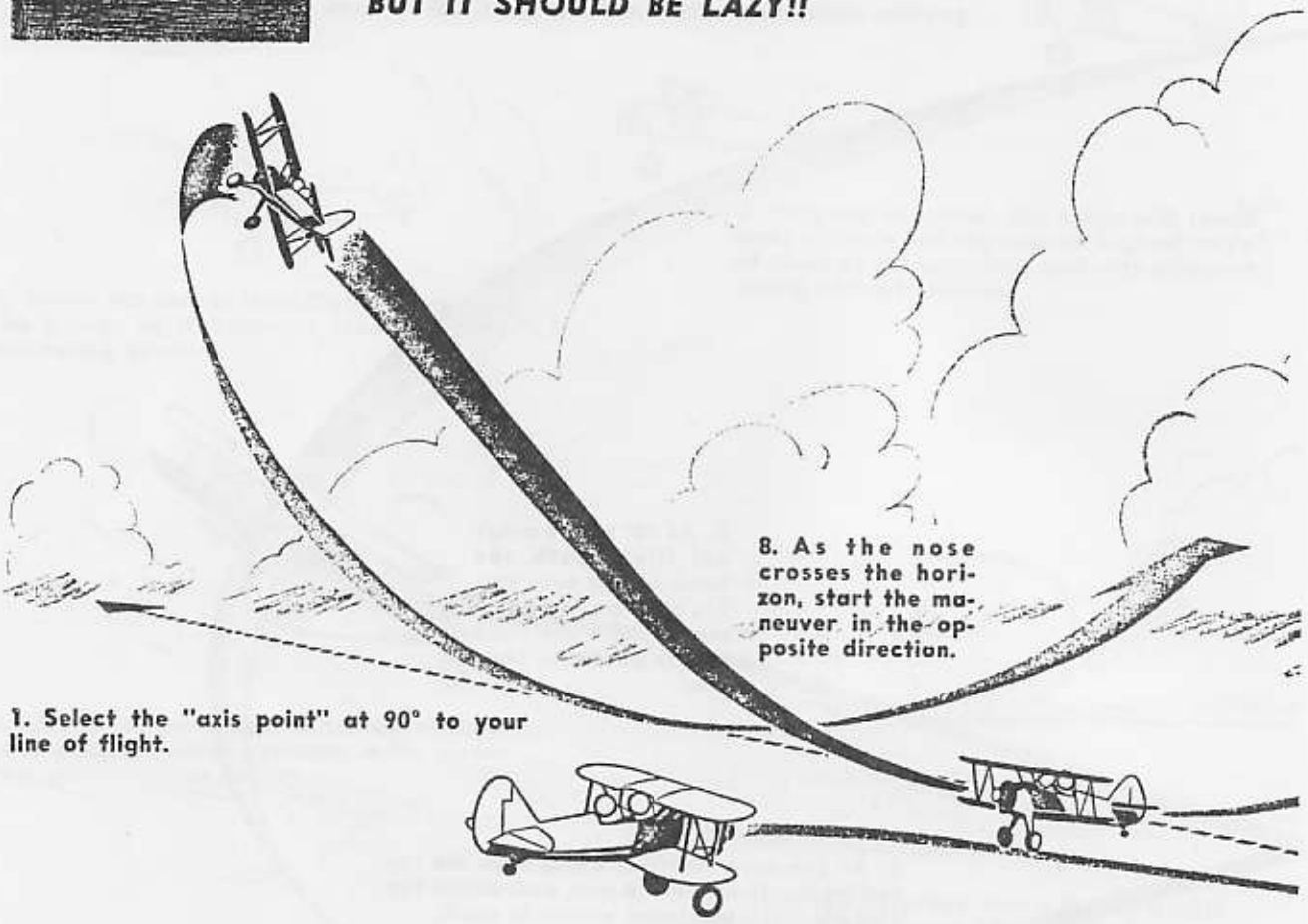


If you have trouble performing the chandelle, it may be caused by your failure to correct for the continuously changing effect of torque. You must bear in mind that torque is changing throughout the maneuver. As the climb is started, and the airspeed begins to decrease, the effect of torque becomes more and more noticeable. In a chandelle to the right, you will feel torque just as soon as you start the climb. As the climb proceeds, the effect becomes stronger. Since torque tends to turn the airplane to the left, the airplane will tend to roll itself out of the turn. At times, this effect actually will be great enough to make it unnecessary for you to make any further corrections to prevent the bank from becoming excessive. During the roll-out, little if any left rudder may be needed.

Conversely, in a chandelle to the left, torque will tend to increase the bank. You will have to apply increasing right control pressures to prevent the bank from getting too steep. In rolling out of a chandelle to the left, you will have to apply enough right rudder to overcome torque as well as to bring the airplane out of its turn.

LAZY 8

THE LAZY 8 MAY NOT BE AN 8... BUT IT SHOULD BE LAZY!!



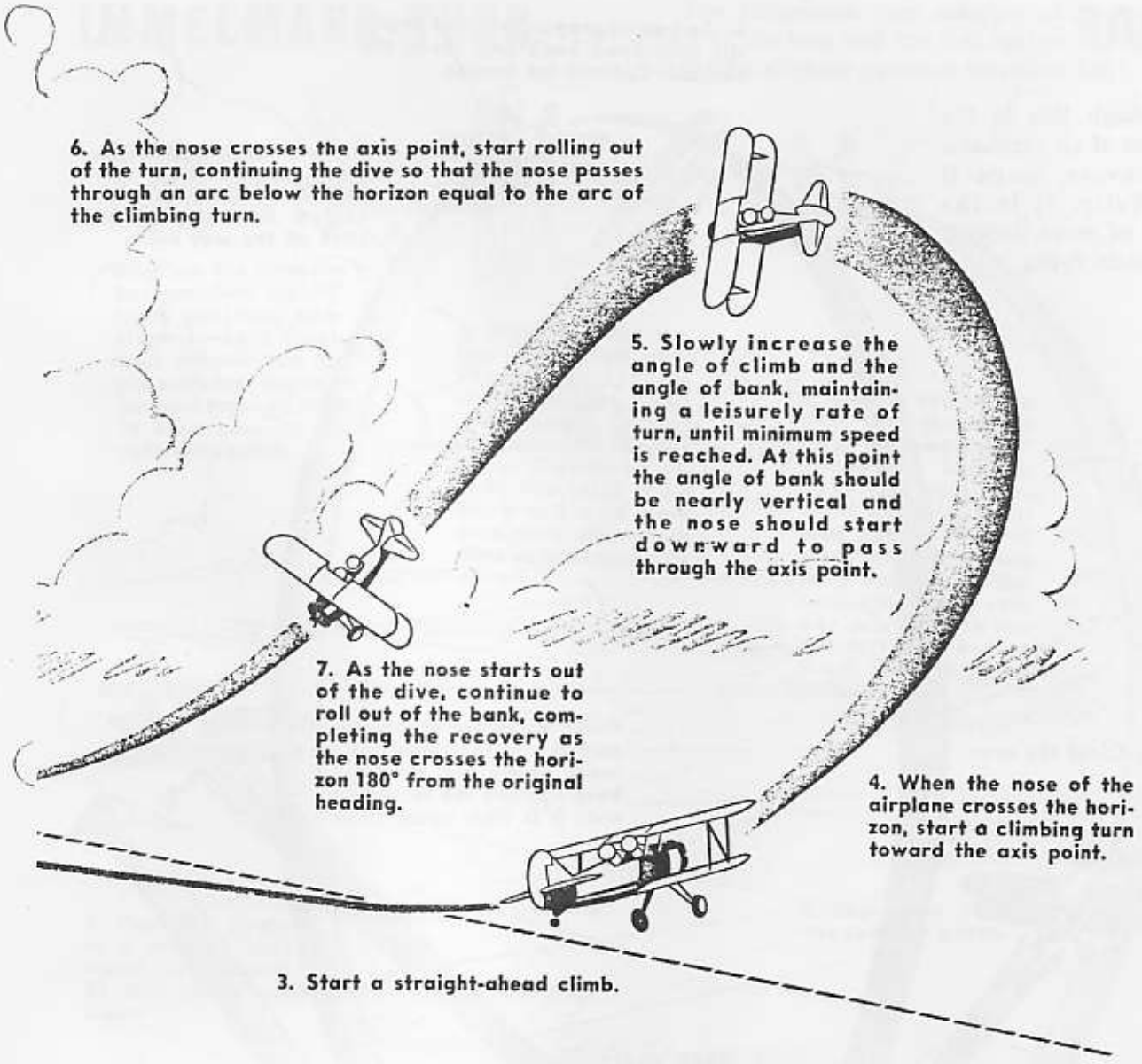
Purpose

The lazy 8 helps to develop timing, coordination, speed sense, and orientation. It is essentially a rhythm maneuver. A lazy 8 should be smooth and lazy. It consists of a dive, a climb, and a turn, blended into a single continuous maneuver, in which the nose of the airplane describes a figure 8 in a vertical plane on the horizon as viewed from the cockpit. A reference point on the horizon, called the "axis point," lies at the center of the eight.

NOTE: There is no straight and level flight in this maneuver, and the nose turns continually with a constant rate of turn. Speed range should vary from 10 to 15 mph above cruising at the bottom of the dive to minimum flying speed without stalling at the top of the climb on all turns.

The Most Common Errors Are:

1. Rate of turn too fast or variable.
2. Rate of roll too fast or variable.
3. Allowing the nose of the airplane to go beyond or short of the axis point.



4. Recovering from the diving turn either too early or too late.

5. Failing to correct for torque.

6. Poor coordination.

7. Failing to watch for other airplanes.

8. Relaxing back pressure to force the nose through the axis point.

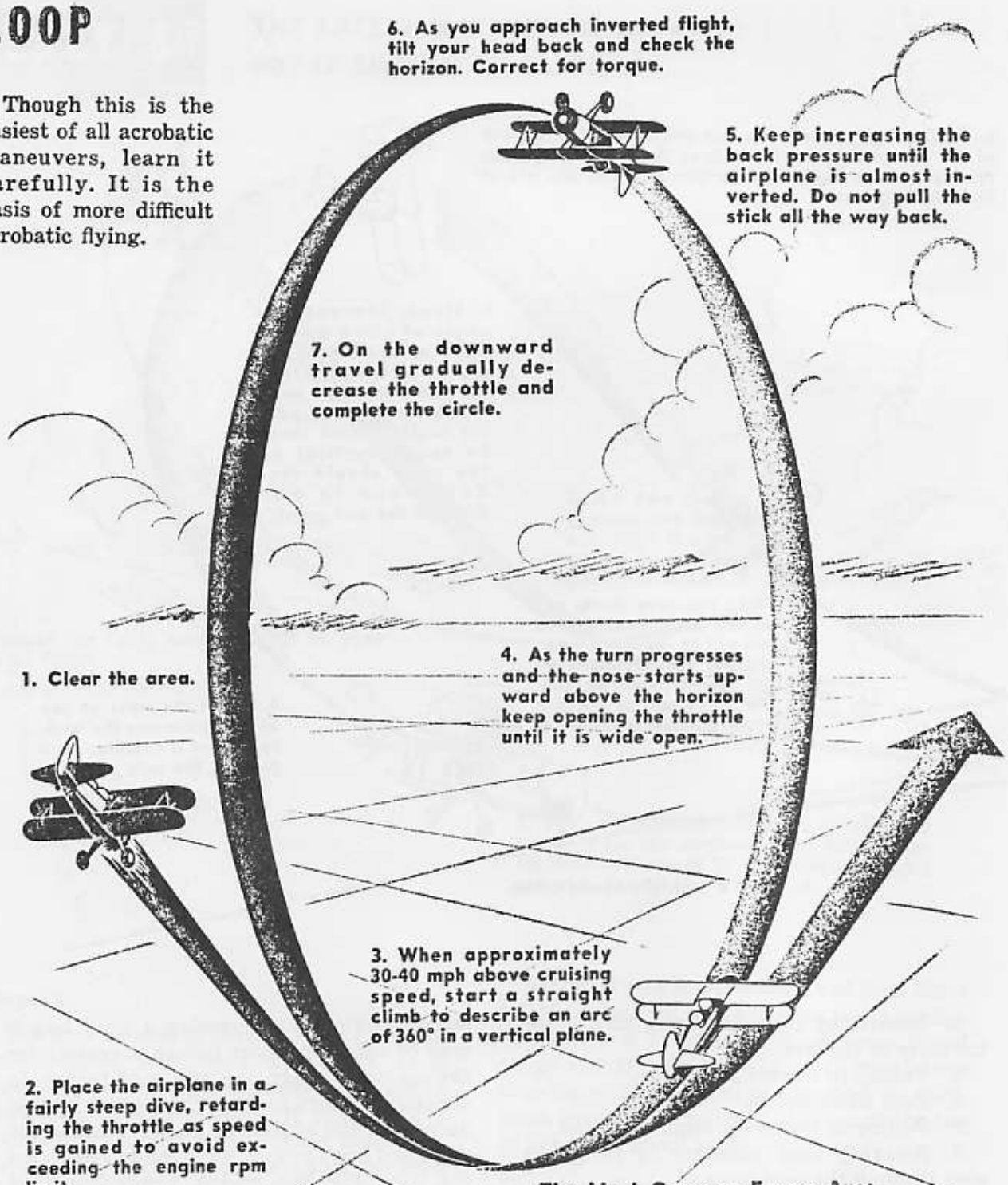
In executing this maneuver, it is important to divide your attention between the airplane, the axis point, the ground, and the surrounding air area. KEEP A CONTINUAL WATCH FOR OTHER AIRPLANES.

Here again, as in the chandelle, your greatest difficulties in performing a good lazy 8 may be caused by your failure to correct for the constantly changing effects of torque. In the climbing turn to the right, as the airspeed decreases, the effects of torque will become more and more evident and tend to slow down the turn. For this reason, increasing right rudder pressure must be applied until the nose crosses the axis point and the airspeed begins to increase.

In a climbing turn to the left, torque will tend to increase the rate of turn so that less rudder pressure will be needed to the left.

LOOP

Though this is the easiest of all acrobatic maneuvers, learn it carefully. It is the basis of more difficult acrobatic flying.

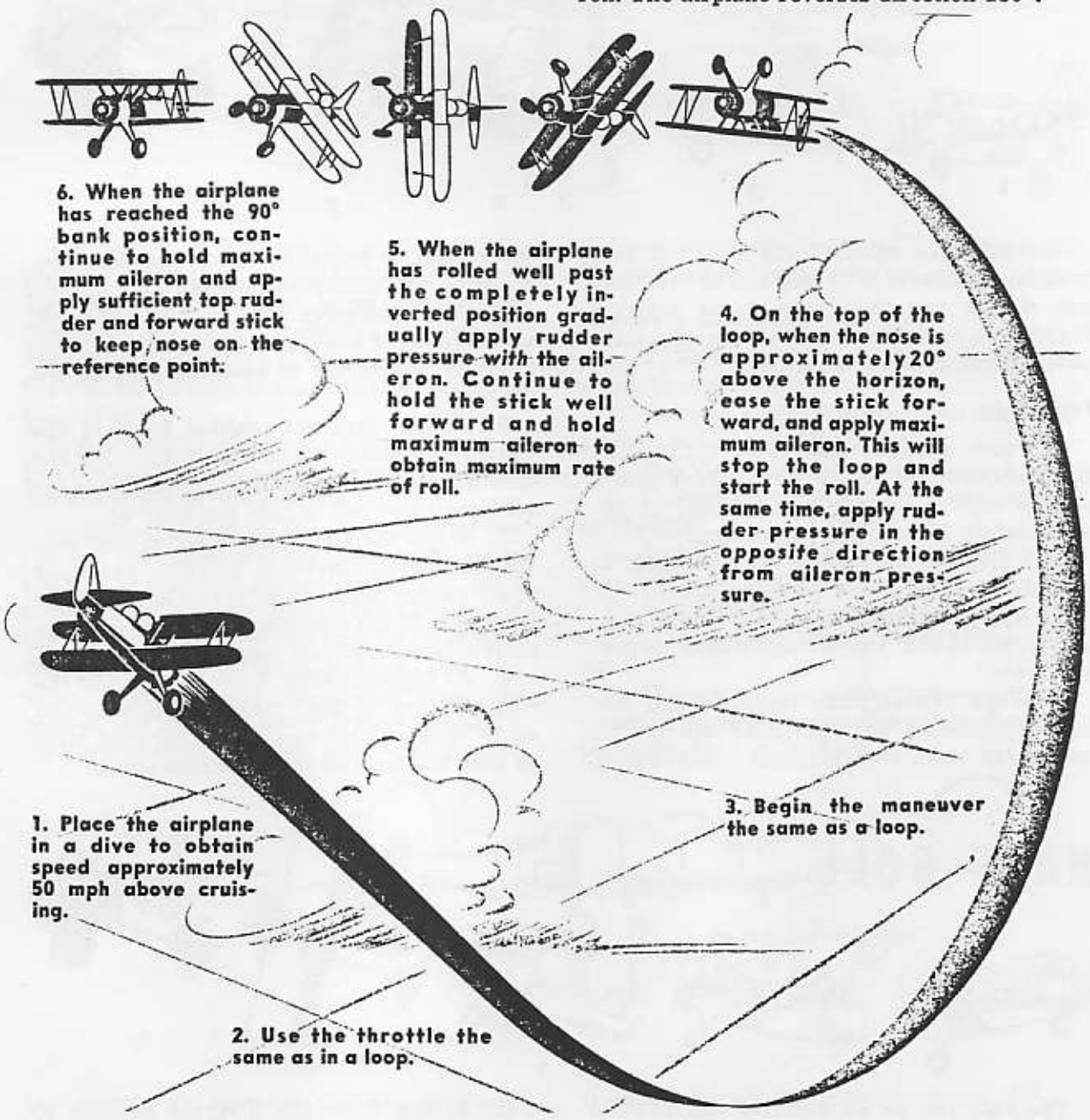


The Most Common Errors Are:

1. Violent use of elevators.
2. Poor throttle use.
3. Improper torque correction.
4. Loss of orientation.
5. Poor speed sense.

IMMELMANN TURN

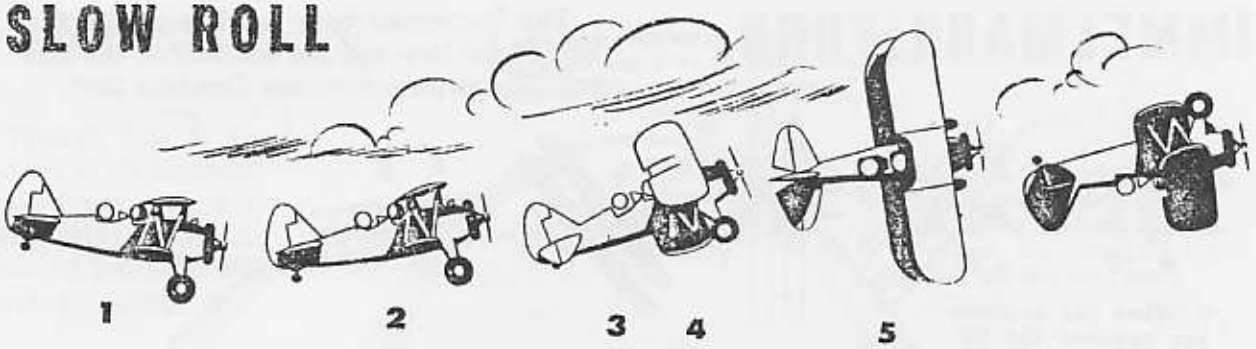
The Immelman turn consists of the first half of the loop and the last half of the slow roll. The airplane reverses direction 180°.



The Most Common Errors Are:

1. Failure to coordinate controls.
2. Use of abrupt rather than smooth control movements.
3. Failure to gain sufficient initial airspeed.
4. Pulling up too abruptly in first half of loop.
5. Pulling up too slowly.
6. Loss of orientation.

SLOW ROLL

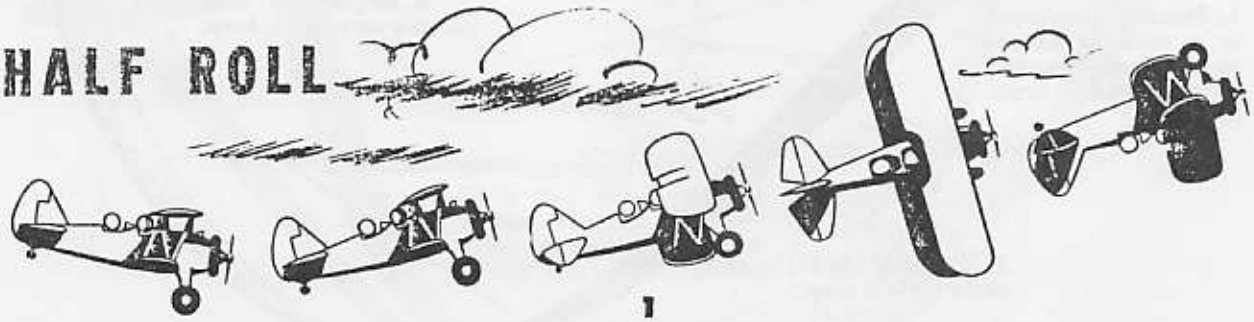


The principal value of the slow roll as a training maneuver is to help you to overcome any doubts you may have about inverted flight. It is valuable as an exercise of coordination, timing, and orientation.

Procedure

1. From straight and level flight with throttle advanced to full power, ease into a shallow dive to obtain excess speed of approximately 20 mph above cruising.
2. Apply back pressure on the stick to ease the airplane into a shallow climb.
3. Apply maximum aileron to obtain maximum rate of roll. Use enough rudder to prevent yaw.
4. When the airplane responds and the bank approaches 45°, the nose will try to turn away from the reference point. Apply top rudder to prevent this turning and continue to hold maximum aileron.
5. As the airplane approaches a 90° bank, apply forward stick pressure along with increasing top rudder to hold the nose on the point.
6. At the inverted position increase the rudder sufficiently to hold nose on point and continue to hold maximum aileron. Keep the stick well forward to hold the nose up.
7. When the airplane has rolled well past the completely inverted position gradually apply rudder pressure with the aileron. Continue to hold the stick forward and hold maximum aileron to obtain maximum rate of roll.
8. At approximately three-quarters of the roll, continue to hold maximum aileron and apply sufficient top rudder and forward stick to keep the nose on the reference point.

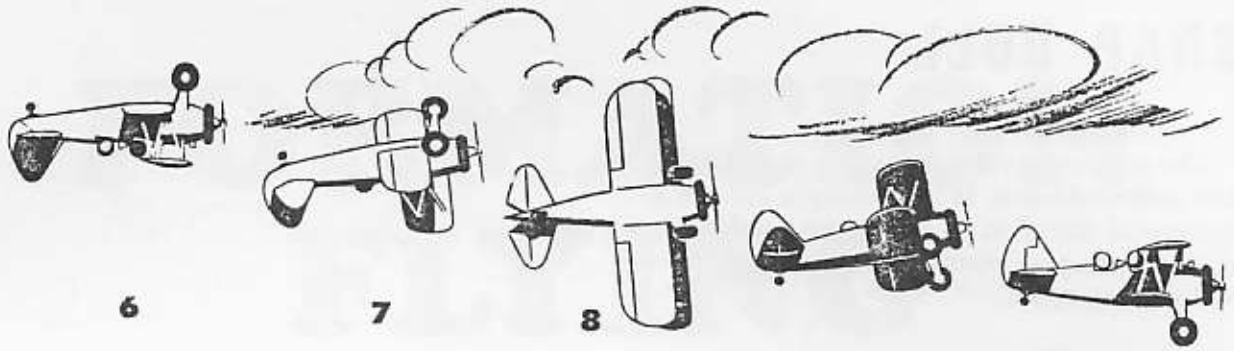
HALF ROLL



The half roll as an exercise will develop confidence, coordination, and orientation.

Procedure

1. As in the slow roll, roll the airplane about its longitudinal axis until it is completely inverted.
2. Neutralize the rudder and ailerons and hold it there momentarily.
3. Rolling from the inverted position to level flight requires the same control useage as the last half of a slow roll. For example, if the roll in was made to the right, then, the roll out to the left would require maximum left aileron. Sufficient opposite rudder would be applied to hold the nose on the point. The stick will be well ahead to hold the nose up.
4. When the airplane has rolled well past



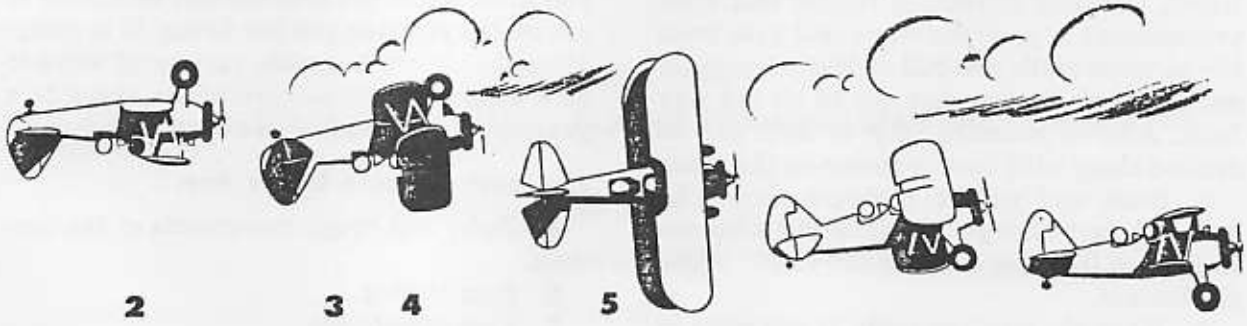
The secret of success in a slow roll is proper coordination of rudder and elevator. The easiest way to learn is to pick a small cloud that is about the right height above the horizon and use it as a target. Throughout the roll, try to keep the nose of your airplane pointed at it.

If you have short legs and arms, use one or two cushions behind your back so you can get the full range of the controls.

Consider yourself as the pivot point of the roll and remember that control movements in relation to the pilot always remain the same regardless of the attitude of the airplane. If the nose moves to the right of the reference, use left rudder to bring it back and vice versa. Likewise, you can always move the nose of the airplane away from yourself by forward pressure on the stick and toward yourself with back pressure. The functions of the controls never change.

The Most Common Errors Are:

1. Failure to select a definite point with which to orient the roll.
2. Leaning away from the bank at the beginning of the maneuver.
3. Relaxing pressure on the ailerons.
4. Failure to maintain forward pressure on the stick.
5. Jerky use of the rudder to force rotation.
6. Allowing the nose to drop below the horizon when approaching the 90° bank position.
7. Changing from rudder pressure in one direction to pressure in the other direction too early, too fast, or both.



the completely inverted position gradually apply rudder pressure with the aileron. Continue to hold the stick well forward and hold maximum aileron to obtain maximum rate of roll.

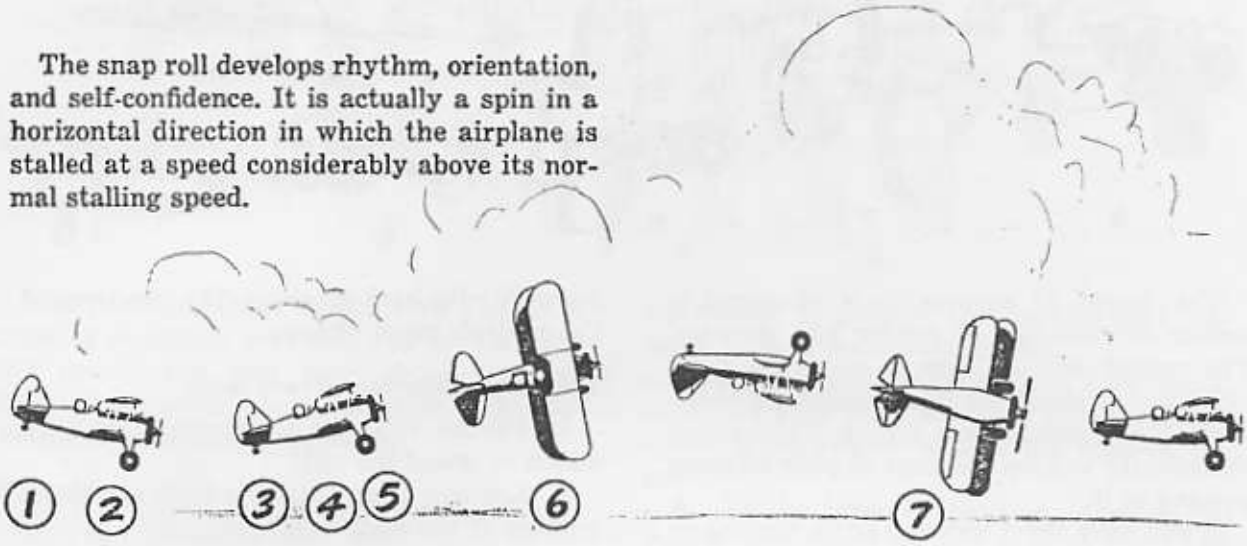
5. When the airplane has reached the 90° bank position, you should continue to hold maximum aileron and apply sufficient top rudder and forward stick to keep the nose from moving off the reference point.

The Most Common Errors Are:

1. Poor coordination and timing.
2. Loss of orientation.
3. Holding the airplane on its back too long.
4. Allowing the nose to drop below the horizon as the 90° bank is approached.

SNAP ROLL

The snap roll develops rhythm, orientation, and self-confidence. It is actually a spin in a horizontal direction in which the airplane is stalled at a speed considerably above its normal stalling speed.



Procedure

1. Place the airplane in a shallow dive to obtain speed about 10 mph above cruising.
2. Advance the throttle to full power.
3. Pull up, as in a loop and as the nose passes the horizon start applying rudder slowly in the desired direction of roll.
4. As the nose continues on its upward travel, continue increasing rudder and stick pressures at a progressively rapid rate until the airplane stalls and full rudder pressure is on. The stick may or may not be all the way back. Aileron pressure may or may not be applied along with back pressure on the stick.
5. Stick and rudder pressure should be built up fast enough to make the airplane stall when the nose is about 30° to 40° above the horizon.
6. When the airplane stalls, it will start to rotate rapidly in the direction of rudder pressure. When this occurs, hold the controls as in a spin, until well beyond the inverted position.
7. As in a spin, start recovery with full opposite rudder followed by forward stick and neutralized rudder as the rotation stops. Ailerons should be used as needed on recovery to stop the wings in a level attitude. Keep the nose above the horizon.

In order to get best results in a snap roll, you must know the best control technique to use on the airplane you are flying. It is recognized that there is a wide variety of ways to do a snap roll, but the procedure above is a general description of the average snap roll.

The Most Common Errors Are:

1. Jerky and rough movements of the controls.
2. Poor timing.
3. Poor orientation.
4. Mechanical rather than rhythmic coordination of the controls.

CHECK THAT SAFETY BELT!

Is the Area Clear?