TECHNICAL NOTES

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

No. 555

PILOTING TECHNIQUE FOR RECOVERY FROM SPINS

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Washington
February 1936

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SUMMARY

Systematic flight investigations of the spinning characteristics of various airplanes over a period of several years have given the pilots engaged in the testing a varied and extensive experience. From this experience certain general rules of procedure have been formulated, particularly for the sequence of operation of the controls in recovery from spins, and are recommended to the attention of all pilots.

INTRODUCTION

Over a period of several years the National Advisory Committee for Aeronautics has done a great deal of flight testing for the purpose of systematically studying the spinning characteristics of various airplanes. For example, over 900 spin tests were made with one airplane whose spinning characteristics were vicious at times, depending on the effect of modifications to the tail and to the load distribution. From the varied and extensive experience gained in these flight tests, the pilots engaged in the testing have learned a number of general rules, pertaining particularly to the routine of control manipulation for recovery from prolonged spins. It is believed that these general rules will be of interest and value to other pilots. Although no method of control manipulation for recovery can be claimed to be infallible, it is believed that the procedure recommended herein should be generally adopted.

PRECAUTIONS DURING SPIN

A rule of great importance for student pilots or for any pilot who is not entirely familiar with all the spin traits of a particular airplane, is that during a spin and particularly during the last 3 or 4 turns of a prolonged

spin before recovery is attempted the ailerons should be neutral and the elevator and rudder controls should be held all the way with the spin.

There are two important reasons for the foregoing recommendation. First, it has been observed that a much "snappier" and more forceful reaction on the part of the airplane toward recovery is obtained when the controls are moved from one extreme to the other. Obviously, having the controls already full with the spin gives assurance that the full range of control deflection is available for recovery. Second, it has been observed that the above-described application of controls produces the steadiest and most uniform spin condition.

The steady spin is desirable since it has frequently been definitely demonstrated that an unsteady or oscillating spin greatly aggravates any confused mental condition that may be present during a spin maneuver. The likelihood of mental confusion and its importance cannot be overemphasized. It is only necessary to mention that on several occasions pilots with extensive experience in spins, including the pilots engaged in the N.A.C.A. spinning investigation, have been known to move the controls to positions opposite to those intended because of their mental confusion or excited condition.

RECOMMENDED USE OF CONTROLS FOR SPIN RECOVERY

The recommended operation of the controls for recovery from a spin, which presupposes that the ailerons are held in neutral throughout the recovery, is as follows:

1. Briskly move the rudder to a position full against the spin.

2. After the lapse of appreciable time, say after at lest one-half additional turn has been made, briskly move the elevator to approximately the full down position.

3. Hold these positions of the controls until recovery is effected.

There are a number of reasons why the rudder movement should precede the elevator movement. The effect of the reversed rudder is to check the rate of rotation and cause

the nose of the airplane to go down. The blanketing of the rudder by the elevator is generally less, and hence the effectiveness of the rudder greater, when the elevator is up. While the rate of rotation is being checked by the rudder, the elevator becomes increasingly effective in assisting recovery. An opposite sequence of operation, that is, one in which the elevator movement precedes the rudder movement, is decidedly objectionable because the usual effect of putting the stick forward while the rudder is held with the spin is an increase in the rate of rotation.

Slow and cautious movement of the controls during recovery is to be avoided. In certain cases it has been found that, with a slow and cautious reversal of the rudder and elevator, spinning will continue indefinitely; whereas brisk operation of these controls would have effected recovery.

EMERGENCY MEASURES

The comparative effectiveness of rudder and elevator control during a spin recovery will be found to vary to a high degree. It is quite possible for a condition to exist wherein the elevator will prove to be a more positive control than the rudder. Even in this event, however, a change in the sequence of control movement is unnecessary and is not recommended.

The advisability of using ailerons as an additional means of recovery is debatable. It is suggested, however, that the use of ailerons relative to the individual airplane be studied, inasmuch as on some airplanes they aid appreciably in recovery, provided that the proper displacement is used. The proper displacement may be either against or with the spin, depending on the particular airplane.

It is not uncommon for a bad-spinning airplane to make at least 5 turns before the recovery control appears to give any satisfactory results. For such airplanes there is always a strong temptation on the part of a pilot to try some other control manipulation when the one originally applied produces no apparent effect in a short time. It is extremely important that such impatience be avoided. The time element itself is likely to be greatly overestimated because of mental confusion. Experience has shown that it is advisable to judge the lapse of time by

the number of turns made. In the event, then, of a vicious spin, a rule of great importance is to hold the controls applied for recovery for at least 5 turns before attempting any other measure to promote recovery.

Use of the throttle in an attempt to recover from a bad spin, although effective at times, is very poor practice and generally should be considered as a measure to be tried only as a last resort. In a prolonged spin considerable difficulty usually is experienced in keeping the engine turning over at idling speeds, a frequent result being a dead stick before the termination of the spin. If power is used to attempt a recovery, it is usually attended by a violent vibration originating in the propeller blades.

In recent years several instances have been reported wherein, as an emergency measure, pilots have stood up in their seats with the result that the airplane recovered from the spin. There appears to be no reason why the airplane recovers under these conditions unless it is because the controls are free. In order to obtain information concerning this point, a number of tests of a single-seat, pursuit-type airplane were carried out in which the controls were released by the pilot after a steady spin had been attained. The pilot remained in his normal position during these spins, noting the movement of the controls and observing the spin. In a number of cases the airplane recovered with the controls free, although the recoveries with this airplane were not particularly satisfactory even when the controls were manipulated in the most effective manner.

GENERAL PRECAUTIONS

It is desired to stress the importance of obtaining a reasonably safe altitude before a spin is started and even then proceeding cautiously. Overestimation of one's ability, unfamiliarity with an airplane's spinning and recovery characteristics, and the habit of starting spins at low altitudes make a vicious combination that has caused many fatal accidents. If tests of an airplane whose spinning characteristics are doubtful are being conducted, it is recommended that an altitude of at least 10,000 feet be obtained before starting a spin.

The first few turns of a spin constitute a transition period from straight flight to the final steady spin, during which recovery is likely to grow progressively more difficult. In spin tests of a strange airplane it is advisable to make use of this period for trials of the ease of recovery at various stages of the spin. In the first trial, for example, attempt the recovery after 1/4 turn and in succeeding trials recover after, say, 1/2, 3/4, 1, 1-1/2, 2, 3, etc. turns. It is quite possible that if this procedure is followed dangerous characteristics will be detected before serious trouble is encountered.

Judgment as to whether the final spin will prove to be uncontrollable should not be based solely on the attitude of the airplane. Uncontrollable spins are not necessarily flat spins. The effectiveness of the controls after the correct displacement has been made is probably generally less for flat spins than steep ones; but the force required to move the controls may be a vital factor and, as explained in the following paragraphs, control forces are dependent on various items that are not related to the spinning attitude.

The magnitude of the control forces required for the proper movement of control surfaces during spin recoveries will be found to vary over a wide range. Although several conditions regulate the forces required for displacement of the controls, the most important factors appear to be the size and weight of the airplane and the area of the control surfaces. In certain cases, forces have been experienced which require the maximum physical effort of the pilot to force the controls to the desired positions. It is recommended that the pilot carefully check his position in the cockpit to assure himself that he can apply maximum force on the controls because the position assumed by the pilot in holding full rudder while the stick is being pushed forward is, at best, awkward.

Discrepancies in rigging will, as a general rule, affect the spinning characteristics to a greater or lesser degree according to the particular type of airplane involved. In general, an airplane will spin differently in a right than in a left spin, owing to the asymmetry in the rigging provided to overcome propeller torque and slipstream effects for normal flight. Thus it is possible that a type of airplane that has been found to be satisfactory in spins may become unsatisfactory if improperly rigged. It is also possible that an airplane may have

satisfactory spinning characteristics for a spin in one direction and unsatisfactory characteristics for a spin in the opposite direction.

Changes in weight and center-of-gravity position are likely to cause changes in the spinning characteristics. Although it would be very difficult to predict the effect of a definite center-of-gravity position on the spinning characteristics, it is recommended that the spinning of airplanes with abnormal center-of-gravity positions be restricted. One point to bear in mind is that with the center-of-gravity position well aft it is usually easy to attain the stall necessary for a spin entry; whereas, if the reverse condition of loading exists, considerable difficulty in stalling the airplane will be experienced and it may be necessary to use power in order to start a spin.

The position of the wheels on airplanes with retractable landing gears is likely to influence the spinning characteristics quite noticeably. Considerable data obtained on several types now in service show that both the spin and recovery are adversely affected when the wheels are down.

Bomb loads on the wings usually have the effect of making the spin recovery more sluggish. The effect of bombs is more evident on airplanes that normally spin with one wing tip well down, and there is a possibility that a bomb load on such an airplane would prove adverse to recovery.

CONCLUSIONS

In conclusion, it seems advisable to restate briefly, for emphasis, the following general rules:

1. During a spin, particularly during the last 3 or 4 turns of a prolonged spin, before recovery is attempted, the ailerons should be neutral and the elevator and rudder controls should be held all the way with the spin.

2. When applying controls for recovery, the rudder should be briskly moved to a position full against the spin and later, after at least one-half additional turn is made, the elevator should be briskly moved to the full down position.

3. In the event of a vicious spin, the applied controls for recovery should be held for at least 5 turns before attempting any other measure for promoting recovery.

4. Deliberate spins should be started at an altitude of at least 10,000 feet.

5. When any doubt exists regarding the recovery characteristics of an airplane, a familiarization method consisting of trials of recoveries at various stages of the transition from straight flight to a steady spin should be employed.

Too much confidence should not be placed in these or any other rules, however, for no method of recovery can be regarded as infallible for all airplanes.

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Langley Field, Va., January 16, 1936.