08
TURNING

AIM

To teach the student to carry out various types of turn and how to turn accurately towards features and on to specified headings.

INSTRUCTIONAL GUIDE

Whilst several types of turn are dealt with in this exercise it will obviously be impossible to teach all these types in one lesson. However, before first solo the student must be competent in performing medium level turns, medium descending turns, both with and without power, and climbing turns. The more advanced types of turns should be introduced after first solo.

Turns are often described as gentle, medium and steep according to the angle of bank used. A turn at an angle of bank of much less than 30° is considered as a gentle turn, one at about 30° a medium turn, and one at 45° or more as a steep turn.

In making an accurate turn an experienced pilot co-ordinates all three main controls so that a smooth, balanced turn results. A student often finds difficulty in doing this, therefore it is better for a student to think of each control as having one definite function during the turn with the ailerons controlling the angle of bank, the elevators controlling the position of the nose relative to the horizon and the rudder balancing the aeroplane, preventing or correcting any slip or skid.

Before flight make sure that the student is aware of the principles of turning, the use of controls, the use of power and the various angles of bank and the speeds and attitudes to be employed in the particular types of turns to be taught during the air exercise.

During the flight the initial emphasis should be placed on the correct judgment of attitude and angle of bank by reference to the natural horizon. As the student becomes more proficient he or she should be made to cross refer to instruments to achieve greater accuracy. It must be stressed that a good lookout is essential both before and during a change of direction.

In aeroplanes with side by side seating, point out to the student the different nose position relative to the pilot when carrying out turns in opposite directions.

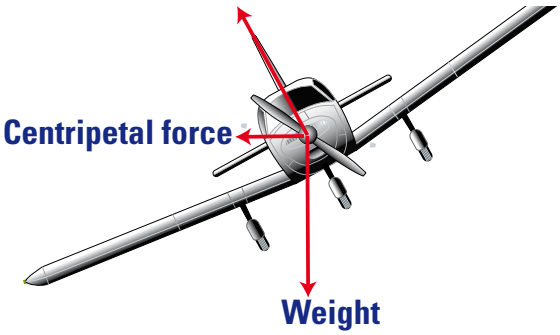
PRE-FLIGHT BRIEFING CONSIDERATIONS

MEDIUM LEVEL TURNS

Definition A medium turn is one carried out with an angle of bank of approximately 30 degrees.

Explain to the student the forces acting on an aeroplane during a medium level turn.

Figure 8-1: Forces acting on an aeroplane during a level turn.



Explain why the aeroplane is banked, ensuring that the student appreciates that the lift must be greater than the weight in order to support the weight and provide the horizontal component to turn the aeroplane – see Figure 8-1.

Explain how to balance the aeroplane with rudder.

Explain the tendency to over bank if this tendency is noticeable on the type of aeroplane in use.

Explain the effect of aileron drag if this is applicable to the type of aeroplane and how it will be demonstrated in flight.

Emphasize how the aeroplane is controlled:

(a) Angle of bank - ailerons

(b) Nose position in relation to the horizon - elevator

(c) Prevention or correction of slip or skid (balance) – rudder

APPLICATION IN FLIGHT

Brief the student on the entry to the turn, the approximate nose position relative to the horizon and the way to maintain the turn. Give an appreciation of the instrument indications that may be anticipated, particularly with reference to the ASI, altimeter, turn and balance indicator and attitude indicator. Explain to the student how to recover from the turn.

AIRMANSHIP

It is essential to keep a good lookout for other aircraft.

CLIMBING TURNS

Explain that the forces acting on an aeroplane during a climbing turn are similar to those in a straight climb except that the aeroplane is banked.

Point out that the angle of bank is restricted to only about a rate one turn, otherwise the rate of climb is decreased markedly.

Explain that there may be a tendency to over bank during the climbing turn. This is due to the outer wing moving faster than the inner and to it also having a larger angle of attack than the inner wing. However, this tendancy is not apparent in most modern designed aeroplanes

APPLICATION IN FLIGHT

Explain that a climbing turn is carried out in a similar fashion to a medium level turn except that climbing power is used and the nose position is higher. Ensure that the student is aware of the correct airspeed and power setting for the exercise.

AIRMANSHIP

The same considerations apply as in medium level turns.

DESCENDING TURNS

Explain that the forces acting on an aeroplane during descending turns are similar to those in a straight descent except that the aeroplane is banked.

Explain that there is usually no tendency to over bank. This is due to the extra lift the outer wing derives from its extra speed, being compensated for by the inner wing having a greater angle of attack.

The rate of descent can be controlled over a wide range by the use of power. Emphasize that where power is used to control the rate of descent the correct airspeed is maintained by use of the elevator.

APPLICATION IN FLIGHT

Explain the method of carrying out a gliding turn. The method is similar to that used to carry out a medium level turn except that no power is used and the attitude is such that the nose is normally appreciably below the horizon. Explain the use of the flaps if applicable pointing out that when they are used the nose position will be well below the horizon to maintain the required speed. The recovery from the gliding turn is similar to the recovery from a level turn, except that the gliding attitude must be maintained. Brief the student on the use of power to regulate the rate of descent. Ensure that there is no doubt regarding the speeds, flap settings, approximate attitudes and power settings to be used during the exercise.

STEEP LEVEL TURNS

Definition A steep turn is one carried out with an angle of bank at or in excess of 45 degrees.

Explain with diagrams the forces acting on the aeroplane in a steep turn. Show the variation of the forces with the steepness of the turn.

Explain that there are greater loads on the aeroplane and that the student will feel an apparent increase in weight

i.e. ‘g’ loading.

The stalling speed is higher due to increased loading. The increase is proportional to the square root of the wing loading.

The maximum angle of bank is determined by the amount of power available.

APPLICATION IN FLIGHT

The steep turn is carried out in the same way as a medium level turn except that the angle of bank is greater and power is increased progressively to counter the increased drag and thus maintain speed. Emphasize that there will be a greater back pressure required on the control column. This back pressure also increases the rate of turn. The controls are used to maintain the turn in the same way as for a medium level turn except that it may be necessary to decrease the angle of bank in order to raise the nose if it is allowed to get too low. This procedure should be explained to the student.

Recovery is as for medium level turns but emphasize that a positive forward pressure on the control column will probably be required to maintain the correct attitude. Power must be decreased to the normal cruising setting.

AIRMANSHIP

In some aeroplanes the visibility during steep turns may be restricted, therefore, extra care must be taken before entering the turn to ensure that all is clear. In some high wing aeroplanes it may be advantageous to raise the wing in the direction of turn to see that all is clear prior to entry.

With the use of high power, engine temperatures should be closely watched to ensure that limits are not exceeded. Handling of the engine controls should be smooth.

STEEP DESCENDING TURNS

Explain that the forces acting on an aeroplane during a steep descending turn are similar to those in a medium descending turn except that a higher angle of bank and higher airspeed is used. This results in higher loads being imposed on the aeroplane and also the pilot.

The steep nose down attitude causes difficulty in estimating the gliding attitude, cross reference to the instruments is therefore necessary to ensure accuracy. Brief the student on the indications of the flight instruments to be anticipated.

APPLICATION IN FLIGHT

The steep descending turn is carried out in the same way as a medium descending turn except that the angle of bank is greater and a higher airspeed is used. Brief the student to anticipate the need for a positive back pressure on the control column during the manoeuvre. If the airspeed is allowed to increase excessively it will be necessary to decrease the angle of bank before attempting to raise the nose.

Recovery is as for a normal gliding turn. In addition the nose of the aeroplane must be raised to assume the correct gliding attitude and speed.

AIRMANSHIP

Owing to the high rate of descent and poor visibility in some types of aeroplanes, it is essential to ensure that the area into which descent is to be made is clear.

Engine temperatures should be closely monitored as they may fall well below operating range on prolonged descents. Unless other requirements are specified, the throttle should be opened to cruising power every 1,000FT during a prolonged glide.

MAXIMUM RATE AND MINIMUM RADIUS TURNS

In this exercise the aeroplane is being flown at the threshold of the stall. It is therefore turning at the greatest rate possible for the amount of power being used.

When full power is used the aeroplane is being flown to its limit and it is turning at the maximum rate possible. Similarly, with take-off flap selected the aeroplane is turning at the minimum radius possible.

APPLICATION IN FLIGHT

These turns are usually only for extreme traffic avoidance in civil flying but are a good exercise in co-ordination and as an illustration of the limit to which the aeroplane may be flown.

Brief the student that the execution of these turns are similar to the steep level turn except that a strong backward pressure on the control column will be needed to achieve the maximum rate of turn especially when maximum power is used. The student must be aware that this back pressure must be released as the aeroplane starts to buffet and the aeroplane flown right at the threshold of, but not at, the stall. Recovery is as from a steep level turn.

Any tendency towards loss of control must be corrected immediately. This is normally achieved by releasing the back pressure on the control column and decreasing the angle of bank with ailerons.

AIRMANSHIP

As with all other exercises a good lookout must be maintained during the whole exercise.

TURNING ON TO COMPASS HEADINGS AND TIMED TURNS

Explain to the student that in general the magnetic compass will only give an accurate indication when the aeroplane is flown in un-accelerated flight.

The errors which are inherent in simple magnetic compasses are caused by the compass needle taking up a position not parallel to the earth's surface. Explain how off-setting the pivot point of the magnet system in relation to its centre of gravity will reduce the effect of magnetic dip.

Explain turning errors in the Southern hemisphere. When turning on to northerly headings the magnet system will be 'lively' and when turning on to southerly headings it will be 'sluggish'. Therefore overshoot when turning on to northerly headings—undershoot on southerly. Point out that the greater the rate of turn the greater will be the degree of undershoot or overshoot.

Explain the acceleration errors when flying on easterly or westerly headings. When increasing speed on these headings an apparent turn to the South results. When decreasing speed on these headings, an apparent turn to the North results.

Explain that both turning and acceleration errors are at a maximum on the cardinal points, and that the direction of these errors is reversed in the Northern hemisphere.

In turbulence it is sometimes easier to mentally calculate the angular change required, divide by 3 and fly the resultant figure in seconds at rate one in the required direction.

APPLICATION IN FLIGHT

Ensure the student is competent at performing level turns on to geographic features prior to introducing turns on to specific headings. Emphasize that such turns are carried out normally at less than rate one and that steady un-accelerated flight is essential if accurate indications are required. Teach the student how to estimate the number of degrees through which to turn, then to turn with reference to the horizon then to check, the heading with the compass. Very small corrections of only a few degrees require only a very small angle of bank and may even be corrected with rudder. In these circumstances the bank angle should amount to approximately half of the angular change.

Timed turns are conducted as earlier explained.

AIRMANSHIP

Whilst using the compass for heading reference the need for a good lookout must not be forgotten.

AIR EXERCISE

(a) Medium turns in level flight

(b) Climbing turns

(c) Descending turns

(d) Steep level turns

(f) Steep descending turns

(g) Maximum rate & minimum radius turns

(h) Turning on to compass headings and timed turns

MEDIUM TURNS IN LEVEL FLIGHT

Prior to commencing the exercise it is essential to demonstrate adverse aileron yaw. If the demonstration has previously been given a refresher demonstration may be required. Following a good lookout rapidly apply aileron (no rudder input) and have the student note that initially the nose travels in the opposite direction to the roll. Repeat the exercise in the opposite direction and from a steep turn to wings level.

Initially have the student make all turns at 30 degrees angle of bank through 360 degrees, rolling out on

(i.e. pointing at) a geographic feature. Rolling out on a specific heading should be delayed until the student is sufficiently skilled at rolling out on a geographic feature.

If the aeroplane has side by side seating it will be necessary to demonstrate turning in both directions due to the different sight pictures.

Having demonstrated level 360 degree turns in both directions it may be prudent to break up the exercise as follows:

Entry – lookout, apply aileron in the direction of turn, rudder in the direction of turn and back pressure on the control column, centralize the aileron control at the desired bank angle.

During – Control pitch attitude with elevator, bank angle with aileron and balance with rudder

Exit – reverse of entry

GENERAL GUIDELINES ON TURNING INSTRUCTION:

- During a visual turn about 85% of the time should be spent on lookout, 10% of the time checking attitude plus lookout and 5% of the time checking instrument indications

Throughout the turn balance, unlike pitch and bank angle cannot be accurately determined by visual cues

The rate of roll determines the amount of rudder required during the entry and exit i.e. quicker roll = more rudder input

In most light aeroplanes a power increase is not required for level turns of 30 degrees bank or less

Anticipate the roll out by about half the bank angle

For small heading changes use a bank angle of about half the angular change

Ensure practice turns of all types are conducted in each direction as a right handed student will often favor turning left and vice versa

CLIMBING TURNS

From a normal climb, having made sure that all is clear, roll into a turn as it is done from level flight but use only a rate one turn. Keep the bank constant with ailerons, the nose in the correct position with the elevators and use the rudder as a balance control. Point out that the instruments, especially the attitude indicator, show both bank and climb. Emphasize the position of the nose in relation to the natural horizon. Remember it may be more difficult to accurately determine the required attitude picture in a climbing turn compared to a level turn.

Demonstrate that increasing the bank angle reduces the rate of climb.

MEDIUM DESCENDING TURNS

Firstly demonstrate the gliding turn. When gliding in the correct attitude ensure that the area is clear of other aeroplanes. Roll into the turn as for a medium level turn, taking care to maintain the correct gliding attitude.

Recover from the turn as for a recovery from a level turn maintaining the correct gliding attitude at all times.

In aeroplanes fitted with flaps demonstrate gliding turns with these extended. Point out the steeper attitude and also that the rate of descent is much higher than without flap. Recover normally and allow the student to practice these turns until proficiency is achieved.

When the student is able to carry out gliding turns both with and without flaps, teach the student to control the rate of descent by use of power.

Emphasize that the selected airspeed is held constant by use of the elevator and the rate of descent is controlled by use of power. Demonstrate that the amount of power required to maintain a constant rate of descent increases as the angle of bank is increased.

STEEP LEVEL TURNS

Initially demonstrate the steep level turn using 45 degrees of bank. As the student progresses the angle may be increased to 60 degrees. This will probably be the maximum angle at which a sustained steep turn can be satisfactorily demonstrated in most training aeroplanes.

Emphasize a good lookout then enter as for a medium level turn but increase the power progressively as bank increase to overcome the increase in drag. Demonstrate that a greater backward pressure on the control column is required to maintain the correct nose position.

During the turn the controls are used in the same way as in medium turns. Point out that if the nose of the aeroplane is allowed to sink too far below the horizon it will be necessary, first to reduce the angle of bank, and then raise the nose to the correct position.

Point out the high rate of turn and the indications of the instruments.

Recover as for a medium turn pointing out that power must be reduced and that a positive movement forward of the control column is required to maintain the correct nose position in relation to the horizon.

STEEP DESCENDING TURNS

The steep gliding turn should be practiced as this manoeuvre is excellent in producing co-ordination and is a good test of a pilot's ability.

Select a speed some 10 knots above the normal gliding speed, this figure depending on the type of aeroplane. Demonstrate that a steep attitude is necessary to maintain this speed. Should the airspeed increase to too high a figure, demonstrate that it may be necessary to first decrease the angle of bank, and then adjust the airspeed.

During this exercise point out to the student how to interpret from the instruments the steep nose-down attitude, the high angle of bank and the high rate of descent.

MAXIMUM RATE AND MINIMUM RADIUS TURNS

Firstly demonstrate this turn by selecting a low power setting. Enter the turn as normal allowing the bank to increase maintaining the height with a backward pressure on the control column until the judder is felt. Relax the backward pressure just sufficiently to cause the judder to stop. Maintain this attitude and point out the airspeed and rate of turn. The aeroplane is now being flown at the threshold of the stall and therefore is turning at the greatest rate possible for the amount of power being used. Now increase to full power and demonstrate that it is possible to increase the angle of bank and thus move the control column further back before the judder is reached. Fly the aeroplane at the threshold of the stall and point out the increased rate of turn. The aeroplane is now being flown to its limit because this is the maximum rate of turn of which it is capable. Repeat the exercise with an appropriate flap setting and ensure the flaps are not over sped, thus flying a minimum radius turn.

TURNING ON TO COMPASS HEADINGS

Fly on any heading and then commence a rate one turn. Point out that the relative movement of the compass needle is in proportion to the rate of turn. Show that if the bank is increased the relative movement of the compass needle bears no relationship to the actual rate of turn and may even show a turn in the other direction. Emphasize that this demonstrates the importance of turning at a low rate when using the magnetic compass as a directional reference, especially at higher latitudes.

Next fly on a southerly heading and start a turn left or right at rate one on to North. Firstly demonstrate the effect of rolling out of the turn when the compass indicates exactly North. Show that when the aeroplane settles down, the heading will be some 20 to 30 degrees from North. Return to a southerly heading and repeat the turn on to North but this time continue the turn until the compass indicates that the aeroplane has turned approximately 30 degrees past North then roll out and hold the aeroplane steady. When the compass has settled down point out that the aeroplane is sufficiently near the selected heading to allow it to be turned on to North by a small final correction.

Repeat the demonstration, this time turning on to South. Show that in this case and at a higher latitude it is necessary to stop the turn some 30 degrees before the compass indicates South.

Demonstrate that when turning on to East or West, it is possible to stop the turn when the compass reads East or West and that little or no correction will be needed to settle accurately on these headings.

When flying on East or West increase the speed of the aeroplane by increasing power or lowering the nose. Point out that the compass shows an apparent turn towards the South. Demonstrate that if speed is decreased by reducing power or raising the nose the compass will indicate an apparent turn to the North although the actual heading of the aeroplane has not changed. Emphasize that this indicates the necessity of maintaining a steady airspeed, especially when relying on the magnetic compass for direction information.

Guidelines for remembering whether to overshoot or undershoot a particular heading in the Southern Hemisphere are:

- The compass is: **Nippy on North Sluggish on South** or
- **Overshoot North Undershoot South (ONUS)**

TIMED TURNS

Compass turns form part of the training sequence because directional gyros can fail. Also a small minority of light aeroplanes are not fi tted with a directional gyro. Given the complexity of compass turns, as indicated above, it is sometimes easier to conduct timed turns i.e. turn at rate one which is three degrees a second. Accordingly, the angular change required is divided by three and the rate one turn is flown for those amount of seconds. This procedure is specially recommended in turbulent conditions.

COMMON FAULTS

The necessity for a good lookout before entering and during all types of turns will have to be continually stressed. Students frequently sacrifice lookout in a bid for greater accuracy.

Faulty turns often result from inaccurate flying and trimming just before entering the turns.

Students may tend to use excessive rudder during turns.

In carrying out steep turns students often fail to realize that the use of the elevator to control height also causes the turn to tighten. It is important, therefore, to point out that during a steep turn it is advisable to reduce the angle of bank before attempting to raise the nose to its correct position, should it have been allowed to sink well below the required position.

For students that are having difficulty with turning it can help to have them roll from a turn in one direction (as soon as the desired bank angle is obtained) to a turn in the other direction.

Gaining height (especially in steep turns) is sometimes due to applying 'back stick' too early. Similarly, losing height (especially in steep turns) may be due to excessive bank angles or failing to apply sufficient back pressure on entering the turn.