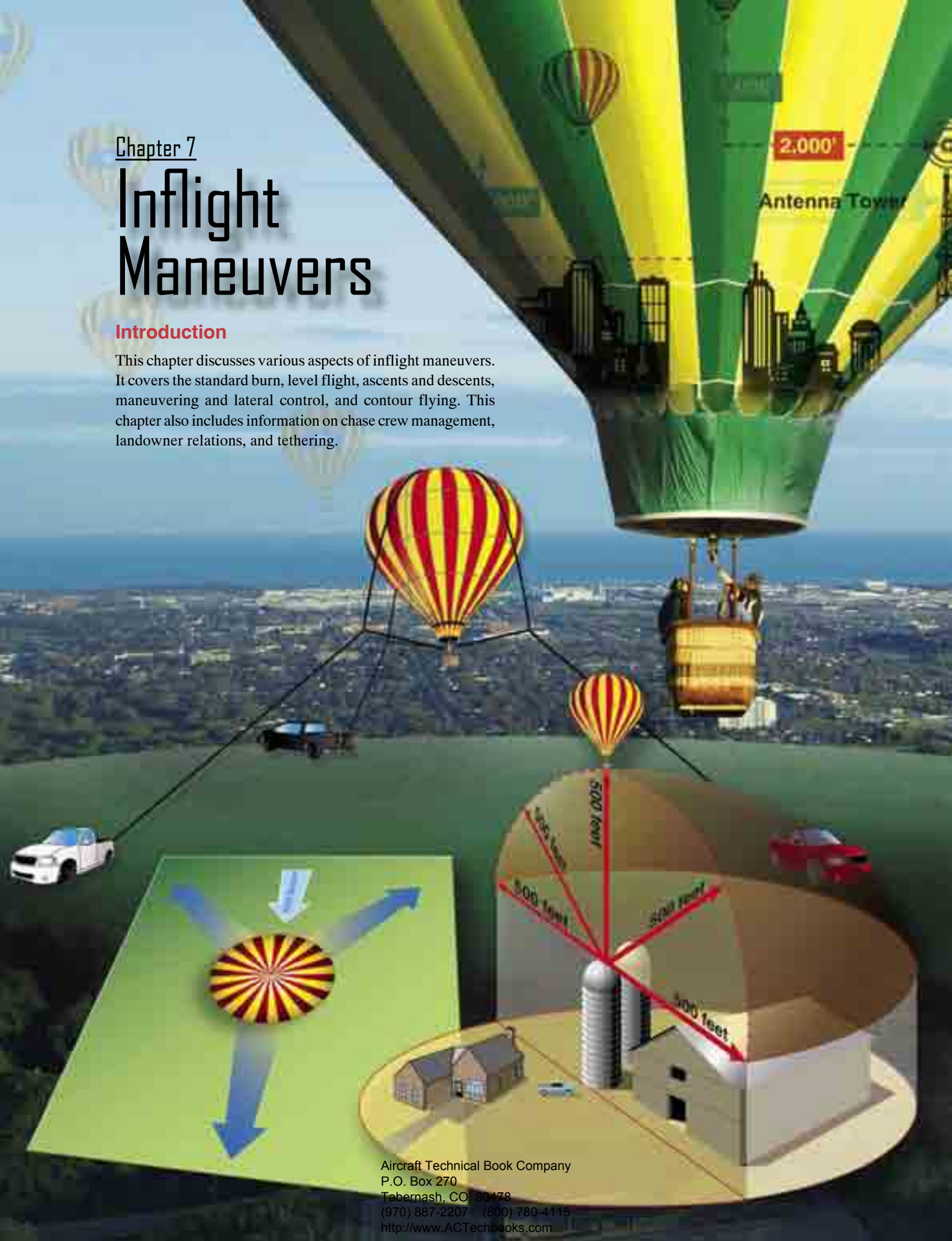


Chapter 7

Inflight Maneuvers

Introduction

This chapter discusses various aspects of inflight maneuvers. It covers the standard burn, level flight, ascents and descents, maneuvering and lateral control, and contour flying. This chapter also includes information on chase crew management, landowner relations, and tethering.



The Standard Burn

To fly with precision, the balloon pilot needs to know how much heat is going into the envelope at any given time and how that heat affects the balloon's performance. Balloon pilots have few outside sources, instruments, or gauges to help them fly. When a balloon pilot uses the burner, there is no direct way of knowing exactly how much lift is increased. Because there are few mechanical aids to help balloon pilots fly, some methodology must be devised to standardize a pilot's input action, so the outcomes of those actions are predictable and the balloon is controllable. The standard burn is one way to gauge in advance the balloon's reaction to the use of the burner. [Figure 7-1]

The standard burn is an attempt to calibrate the amount of heat being used, and is defined as a burn of four seconds. If each burn can be made identical, the balloon pilot can think and plan, in terms of number of burns, rather than just using random, variable amounts of heat with an unknown effect. The standard burn is based on using the blast valve or trigger valve found on most balloon burners. Some brands use a valve that requires only a fraction of an inch of movement between closed and open, and some require moving the blast valve handle 90°. While the amount of motion required to change the valve from fully closed to fully open varies, the principle remains the same—make each burn identical to another.

The inexperienced pilot should begin with the premise that the average balloon requires one standard burn of four seconds every 25 to 40 seconds in order to maintain level flight. Experience determines the exact length of time between burn intervals, and how other variables such as weight and ambient air temperature affect those intervals. The primary goal is to determine the rhythm of burns necessary to maintain level flight. All other maneuvers, then, become a departure from this point. The burn begins with the brisk, complete opening of the blast valve and ends with the brisk, complete closing of the valve at the end of the burn. During their training, some pilots count “one, one thousand; two, one thousand; three, one thousand; four, one thousand” to develop the timing.

The standard burn does not mean a burn that is standard between pilots, but rather, it is an attempt for the individual pilot to make all burns exactly the same length. The goal is not only to make each burn exactly the same length, but also to make each burn exactly the same. The pilot must open and close the valve exactly the same way each time. Most balloon burners were designed to operate with the blast valve fully open for short periods of time. When the blast valve is only partially opened, two things happen:

1. The burner does not operate at full efficiency, and

2. The pilot is not sure how much heat is being generated.

Burner Ratings

During any discussions of burner output, talk usually turns to the issue of “burner ratings”; that is, the amount of heat actually produced by a specific burner. Invariably, the talk turns into a “my burner is better than yours” type of exchange. In reality, there is virtually no difference between the burners produced by the major manufacturers and their respective output.

A pilot needs to understand the concept of British Thermal Units, or BTU, as a measurement of output. A BTU is defined as the quantity of heat required to raise the temperature of one pound of water by one degree Fahrenheit. While not particularly relevant to heating air, this has come to be a generally accepted form of measure for burner output. Of the four major manufacturers, three rate their burners at 18 to 19 million BTU output; the fourth at 43.9 million (with the caveat that that is produced at a supply line pressure of 200 PSI, well above the pressures that most balloonists use). A pilot needs to be aware that BTU output in a balloon burner equates to the amount of propane that is burned in an hour; BTU output is usually computed on this basis. Referring to the Propane Primer in Chapter 2, propane has a nominal value of 91,600 BTU per gallon under ideal circumstances. A simple mathematical calculation indicates that the average burner (a 18.5 million BTU rating) consumes approximately 202 gallons of fuel per hour. (18.5 million BTU divided by 91,600 BTU per gallon of propane = 201.96 gallons of fuel)

However, balloon burners are not used for an hour at a time; instead, they are used for very short periods of time, as discussed on page 7-2. If the numbers above are recalculated, it can be said that the standard burn of four seconds, as described in this section, puts approximately 5,139 BTU of heat into the balloon's envelope. Remember, this is a theoretical statement of heat available, as no burner is 100 percent efficient.

There are numerous factors involved in burner design, such as volume backpressures, restrictions in the internal plumbing design, and more, all of which contribute to the final output rating. It is helpful to remember that the mathematics of burner design reveals the fact that output is a linear equation, when compared to pressure input; there is a direct correlation between the fuel line pressure and the burner's output. This is not the case with the noise output of the burner, as the noise output increases exponentially as the pressure is increased. Reduction of burner noise represents the next hurdle in burner design; perhaps someday it will be possible to enjoy an almost silent balloon flight.

—Mark West and Martin Harns, Aerostar International, Inc.

Figure 7-1. Burner ratings and calculations.

A partially opened valve is producing a fraction of the heat available, but there is no way of knowing what the fraction is. [Figure 7-2]



Figure 7-2. Activated burner.

Another advantage of briskly opening and closing the valve is to minimize the presence of a yellow, soft flame. During inflation, for instance, a strong, narrow, pointed flame that goes into the mouth opening without overheating the mouth fabric or crew is desirable. A partial-throttle flame is wide and short and subject to distortion by wind or the inflation fan. If less than a full burn is desired, shorten the time the valve is open and not the amount the valve is open. Due to burner design (and the inefficiency of a partially opened valve), four 1-second burns do not produce as much heat as one 4-second burn.

If the mechanical aspects of flying can be learned, the systematic cadence can be converted into a rhythm that is smooth and polished. With practice, the rhythm becomes second nature and pilots fly with precision, without thinking about it. Using the standard burn, pilots can better predict the effect of each burn, minimize the potential danger of a burn to the envelope, and have a better flame pattern. The standard burn is referred to when discussing specific maneuvers.

Straight and Level Flight

Level flight, or equilibrium, is probably the most important of all flight maneuvers, as it serves as a baseline from which all other maneuvers are derived. A good pilot maintains level flight with a series of standard burns.

Level flight is achieved when lift exactly matches weight and the balloon neither ascends nor descends, but remains at one altitude. For every altitude, there is an equilibrium temperature. If a pilot is flying at 500 feet mean sea level (MSL) and wants to climb to 1,000 feet MSL, the balloon temperature must be increased. This is not only to attain equilibrium at the new (higher) altitude, but some excess temperature must also be created to overcome inertia and get the balloon moving.

Theoretically, if a pilot were to hold a hot air balloon at a constant temperature, the balloon would float at a constant altitude. However, there is no practical way to hold the envelope air temperature constant. Each time the pilot burns, the balloon tends to climb. The air in the envelope is always cooling and the balloon tends to descend. If the subsequent burns are perfectly timed, the balloon flies in a series of very shallow sine waves. [Figure 7-3, Line A] Of course, any variable changes the balloon flight. A heavier basket load, higher ambient temperature, or sunny day all require more fuel (by shortening the interval between burns) to maintain level flight.

In discussions of level flight, the terms “flying light” and “flying heavy” are sometimes used and bear explanation. A balloon is said to be “flying light” when the sine wave being described in the air is predominately on the high side of the desired altitude [Figure 7-3, Line B]. Many new or inexperienced pilots tend to fly light, and use the vent line in order to return to the desired altitude; this may create a situation where the pilot gets into a constant overcontrolling exercise and is best avoided. “Flying heavy” can be described as a scenario where the sine wave is predominately on the low side of the desired altitude [Figure 7-3, Line C]; if the balloon is left alone, it tends to fall. Flying heavy can be hazardous when contour flying. A balloon pilot must use all visual cues available and exercise a “finesse” type of control when contour flying (described later in this chapter).

Through experimentation, standards can be established that may be used as a basis for all flights. With practice and using the second hand of a wristwatch, a new pilot can fly almost level. The exercise of learning the pattern of burns (each day and hour is different) is an interesting training exercise, but not a practical real-life technique. The ability to hold a hot air balloon at a given altitude for any length of time is a skill that

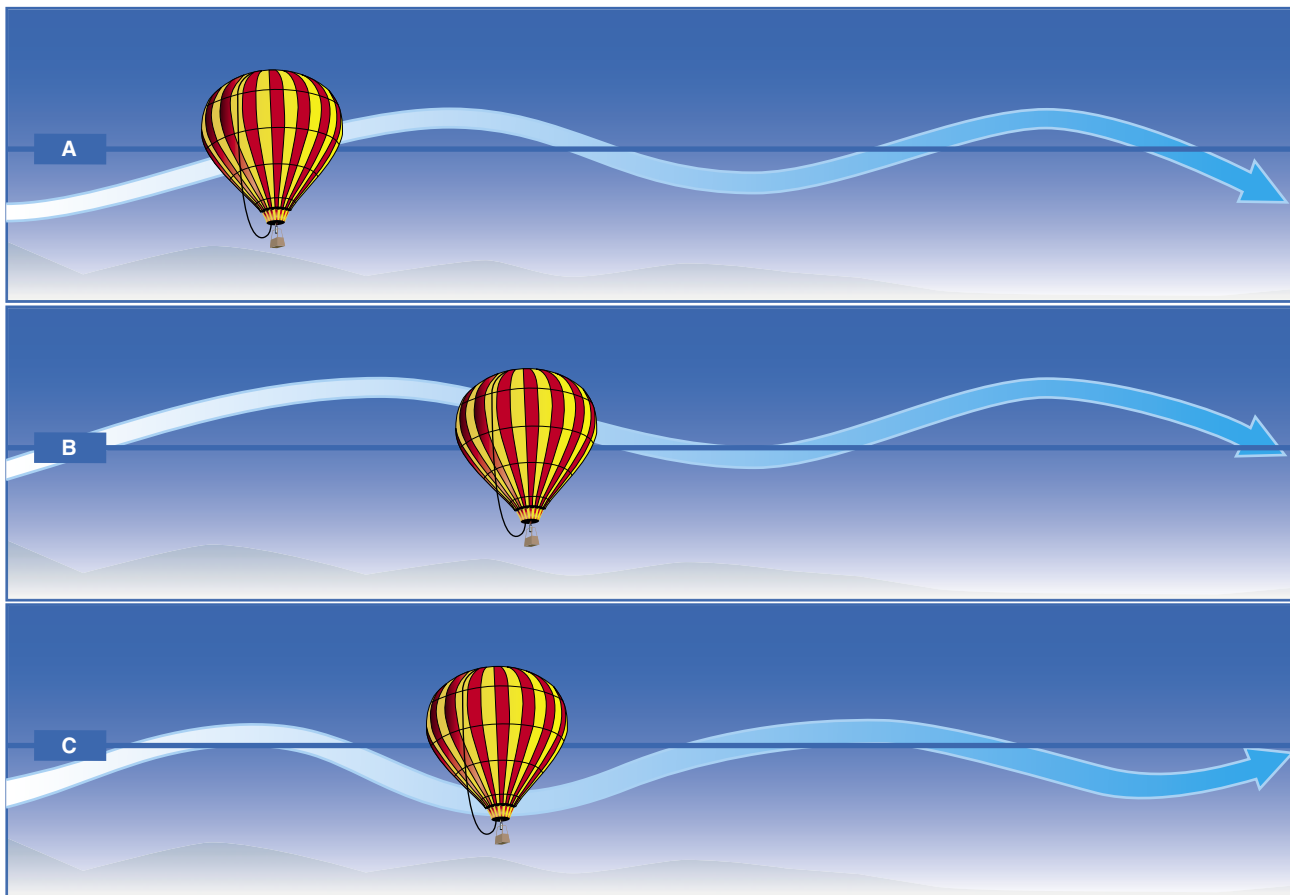


Figure 7-3. Example of normal flight (Line A), flying light (Line B), and flying heavy (Line C).

comes only with serious practice. Unfortunately, most pilots do not spend enough time practicing level flight. During the practical test, given a choice of altitudes, it is easier to fly level at a lower altitude, due to the ease of acquiring visual references. However, the pilot must exercise care not to violate minimum safe altitude requirements (explained later in this chapter), and must be constantly alert for obstacles such as power lines in the flightpath.

Ascents and Descents

The temperature of the air inside the envelope controls balloon altitude. A balloon that is neither ascending nor descending is in equilibrium. To cause the balloon to ascend, increase the temperature of the air inside the envelope. If the temperature is increased just a little, the balloon seeks an altitude only a little higher and/or climb at a very slow rate. If the temperature is increased significantly, the balloon seeks a much higher altitude and/or climbs faster. If the balloon is allowed to cool or hot air is vented, the balloon descends.

Even without the input action by the pilot, it must be remembered that the air inside the envelope is dynamic. The air mass is constantly moving within the confines of the envelope, attempting to seek a level of equalization. While it

varies with each envelope, input action by the balloon pilot can take from 6 to 15 seconds to be realized as a reaction by the balloon. Planning the maneuver, anticipating the reaction time, inputting the proper burn, and observing the reaction must result in smooth and natural movement by the pilot.

Ascents

Using evenly spaced, identical standard burns to fly level, a pilot needs to make only two consecutive burns to have added excess heat to make the balloon climb. For example, if the pilot can maintain level flight with a standard burn every 35 seconds, and then makes two burns in succession instead of one, the balloon has an extra burn and climbs. How fast the balloon climbs depends on how much extra heat has been added. Under nominal conditions, if the standard burn has been made to hold the balloon at level flight and a second burn is within a few seconds (not waiting the 35 seconds), the average balloon starts a slow climb. Three consecutive burns results in a faster climb.

Once the desired climb rate is established, return to the level flight routine to hold the balloon at that rate. The higher the altitude, or the faster the rate of climb, the shorter the interval between burns. In an average size balloon (usually a 77, 000

or 90,000 cubic foot envelope) at 5,000 feet, the pilot may be required to make a standard burn every 15 to 20 seconds to keep the balloon climbing at 500 feet per minute (fpm). At sea level, the same rate may require burning only every 30 to 40 seconds. Burn rates cannot be predicted in advance, but practice provides a basis to begin with and experimentation finds the correct burn rate for a particular day's ambient temperature, altitude, envelope size, and balloon weight.

Another skill to develop in ascents is knowing when to stop burning so the balloon will slow and level at the chosen altitude. The transition from a climbing mode to level flight involves estimating the momentum and coasting up to the desired or assigned altitude. One methodology is illustrated in *Figure 7-4*. During this flight, the pilot has decided to leave his current altitude (A) and climb to another (C). While climbing, the pilot adjusts burn times to be at a 100 fpm rate of climb by the time he or she is at a point 100 feet below the desired altitude (B). Under most circumstances, the balloon "coasts" the additional 100 feet and rounds out, or resumes level flight, at the desired altitude. It may be necessary to use the vent for a short time to stop the ascent with caution not to vent excessively, thereby causing the balloon to go

into a descent. The balloon pilot must remember that each manufacturer has a specific interval that the vent can be opened while in flight. Should that interval be exceeded, it can have a disastrous result. With practice and application, the pilot can learn this skill without the use of the vent, not only conserving fuel, but also flying a much more controlled flight.

Generally, to achieve a smooth transition to the new altitude, the rate of ascent should not exceed the distance to the new altitude. For example, if the balloon pilot is 500 feet below the desired new altitude, the rate of climb should not exceed 500 fpm. When the pilot is 300 feet below the desired altitude, the rate of climb should not exceed 300 fpm. An ascent of 200 to 300 fpm is slow enough to detect wind changes at different altitudes, which is helpful in maneuvering. Above 500 fpm, it is possible to fly through small, narrow wind bands or wind with very small direction changes without noticing. It is a good idea to launch and climb at a slow speed (100 to 200 fpm) to make an early decision regarding which direction to fly.

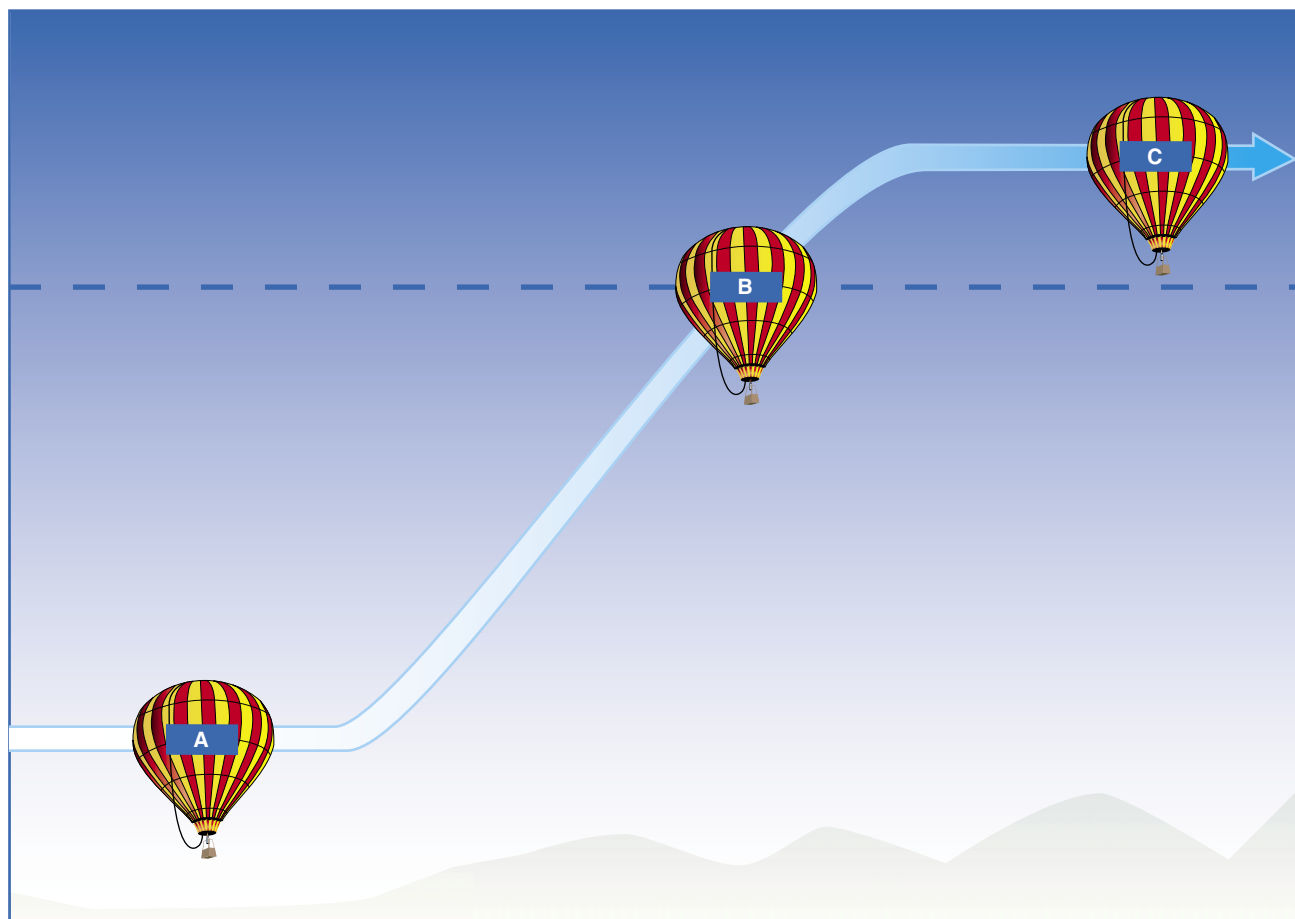


Figure 7-4. *Ascent schematic.*