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BLIND
OR
INSTRUMENT FLYING?

Instruction Book

By

HOWARD C. STARK

Price $1.00

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Preface

THE information on the use of the various instruments described in this book pertains particularly to their value when no outside reference is available to the pilot, that is to say, when he is entirely dependent upon the instruments to maintain normal flight on a chosen course, and to make deliberate turns for the purpose of changing course, also the proper arrangement of the instruments on the board, which is necessary before instrument flying can be done successfully.

Since the equipment on the market consists of two groups of instruments, the instructions will be referred to as the Sperry Group (the direct method) and the Turn Indicator Group (the 1-2-3 Order).

Needless to say, no pilot can afford not to be familiar with both methods, as well as with the use of various combinations of the two, for it is quite possible to have one or more instruments out of commission, even if both complete sets are available, and both groups should be available to ensure safety in instrument flying.

There is a distinct difference between a blind flier and an instrument flier. Many pilots have been able to fly through an area where they could not see outside the plane, by trusting the natural stability of the ship and being so favored by the absence of bumps as to be able to keep somewhere near the course by the magnetic compass. This procedure fails when the air is rough and the compass begins to swing and is invariably fatal if the airplane is unstable.

A common error is to believe that one can fly by the natural sense of balance. It has been proven that this is not so, the reasons being that the human equilibrium is maintained by three things:

First: The level of the liquid in the canals of the inner ear.

Second: Muscle balance.

Third: Vision.

Any pilot can test for himself how useless the first two are by flying as a passenger through a series of turns with his eyes shut. If the turns are good the liquid in the ears keeps the same level as in straight flight, and the muscle pressure on the

seat is equal on both sides. These same sensations indicate that he is vertical and only by opening his eyes and looking at the earth, cloud edges, etc., will be realize that he is both banking and turning. It is obvious, therefore, that when flying in a uniform cloud, the pilot cannot distinguish between banking and turning and straight flight, just as the ball-bank indicator cannot show any difference between a properly banked turn and straight flight. Remember that the pilot has no internal machinery which is not affected by the same influences as the ball-bank indicator.

In the following paragraphs I will describe a few of my own experiences to show the difference between blind flying and instrument flying. It is possible to fly blind a number of years (by not knowing the proper use of the instruments) without any serious difficulty; still it is very dangerous for there is always the chance that the plane may get out of control, with possibly fatal results. With instruction and practice this danger can be eliminated to a great extent, and it will many times avoid the necessity of using the parachute, which pilots resort to when they discover they cannot use the instruments properly.

From 1922 until 1927 I was a barn-stormer, and at the end of this time I decided to try flying the mail. In the fall of 1927 I began flying the night mail with Colonial Air Transport on the Boston to New York route, and henceforth encountered many experiences in bad weather. At that time I was unable to obtain from other pilots a definite rule for the use of the instruments. Their reply was usually "Keep them centered".

I found that was not sufficient information, for I could not keep them centered satisfactorily. I continued to fly all the bad weather I possibly could; in fact, did not find it difficult to fly blind, and considered myself a pretty good blind flyer until my last month on this route.

One day, with a 700-foot ceiling, I decided to go up and practise blind flying. I climbed up to 4000 feet and made a few sharp turns very successfully, but on making the last turn I was unable to straighten the plane out and did not know what was taking place. The turn indicator hand went to the corner. I would center it and then the ball would go out. I could not center both of them at the same time.

By this time the plane's speed was 120 miles per hour. I shut off the motor but continued to gain speed, passing 160 miles per hour I came out of the clouds. I then knew I was in a spin, pulled out, and was grateful for the 700-foot ceiling. After this experience I was not so confident in my blind flying, for I had

found I really could not keep control of the plane if I lost my balance, and this might occur to anyone in rough air such as thunderstorms or line squalls. So I concluded that I was a blind flyer, but not an instrument flyer.

I left Colonial and took a position with National Air Transport, flying the New York to Cleveland route. I flew six months on this route, thus completing at least three years of blind flying. It was at this time that I formulated a definite rule for reading and using the instruments, such as are hereafter described in detail under the 1-2-3 Order (Turn Indicator Group). This was possible due to the proper instrument equipment and maintenance which I found in all National Air Transport planes.

I practised instrument flying for the next six months, using the 1-2-3 Order, flying through thunderstorms to prove at least to my own satisfaction that rough air does not affect the reading and application of the instruments.

I left National Air Transport in February, 1930 and flew for the New York, Rio & Buenos Aires Line in South America. For seven months I flew a Fleetster on pontoons on a night route from Buenos Aires, Argentina, to Porte Alegre, Brazil. It was a run of 625 miles along the coast of virgin country, and was flown without the aid of weather reports, radio, or beacon lights. During that time I did not cancel or delay a trip. On this route I encountered from two to four hours of instrument flying at a time, through conditions that varied from dense fog with calm air, to the roughest thunderstorms I had ever been in. The 625-mile route required four different compass readings, since the plane was on pontoons and it was thus necessary to follow the coast. During a day flight, I made notations of the four different compass readings and timed each of the courses. The trips were flown regardless of weather either by seeing the coast or flying by instrument. If blind, the courses were flown and changed after allowing the proper time for each section of the trip.

After the above experiences, I believe instrument flying can be done safely except when ice conditions prevail or the motor stops.

Judgment of the Weather

ABOVE all, the pilot's judgment of the weather is of the utmost importance in instrument flying. Pilots should carefully consider it before starting a trip, because a misinterpretation of the weather may result in an accident.

With experience in instrument flying, there are many conditions under which one can fly safely. For example: through a local storm with good weather on each side, or through bad weather at the starting point when it is clear at the destination. If the weather is bad at the other end, the trip can be attempted by flying under it, even if the pilot finds that to keep at a safe altitude he must fly by instruments through some low clouds for short periods of time. This condition is safe to continue in, but if the pilot is continuously blind he should turn around and go back, for a plane cannot land at its destination without ceiling. By using this method many trips can be made safely which according to the weather report would look almost impossible.

When there is generally bad weather with low ceiling at both ends of the run, or when ice conditions prevail, no trip should be attempted.

Much has been said about thunderstorms. The thunderstorm condition is not unusual to some air mail pilots. In a thunderstorm the plane is never out of control of an instrument flyer.

It is understood that when a pilot enters a thunderstorm from the front, as soon as he goes blind the plane will be lifted 2000 or 3000 feet, very smoothly but very fast. It is useless to try to stop the rise by diving. It is best simply to maintain normal flying speed and keep on the course. Obviously when flying by the 1-2-3 Order under these conditions, a strict adherence to the rule would result in a dive, as the climb indicator will show a marked "up" reading. Therefore, the airspeed indicator should be used and kept at "cruising" in this case.

As soon as the plane stops going up it will enter very rough air—cold, rain, probably hail, but not too rough to fly a course by instruments.

There is very little danger of lightning when in the clouds, but dangerous when under or between them. There are no down currents of any extent.

A thunderstorm can be flown through if the pilot wishes, for experience. But on mail routes most of the worst of them can be missed, and still stay within sight of the ground. A fog condition may be encountered after the storm for a ways.

There is little reason to cancel trips because of thunderstorms.

The Instrument Board

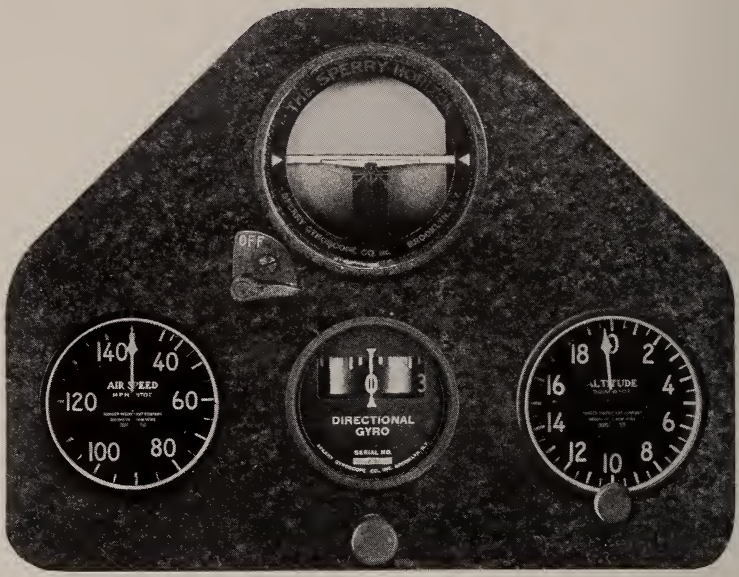

Fig. 1—Correct arrangement of Sperry Group only.

THE proper arrangement of the instruments on the board is very essential for the pilot.

They should be placed on the board in the sequence in which they are used so that they can be read quickly in order to avoid confusion to the pilot.

The Sperry Horizon and Directional Gyro preferably should be placed with the former above the latter and in the center of the board. This arrangement places the horizon bar close to the compass card of the Directional Gyro with a very small distance for the eye to move from one to the other.

It is exceedingly important to have the airspeed, turn, bank and climb indicators (Turn Indicator Group) *concentrated* and placed as near the compass as possible. This arrangement is considered the best at the present time by the majority of companies.

The instruments shown in Figure 2 are arranged in the rotation in which they are read when in flight.

The airspeed, turn and bank are used to climb, glide and in landing.

The turn, bank and climb to maintain level flight.

The climb to maintain a certain height on the altimeter.

With this arrangement you are only using two instruments that are next to each other at any one time.

The grouping shown in Figure 3 combines the two flight systems in a small space and can be placed in the center of the board with the other instruments conveniently grouped around. Also, on planes where there is excessive vibration on the instrument board, a separate panel with the two flight groups can be suspended by shock absorbers. In cases where the magnetic compass is above, the clock or second altimeter can replace it in this grouping.

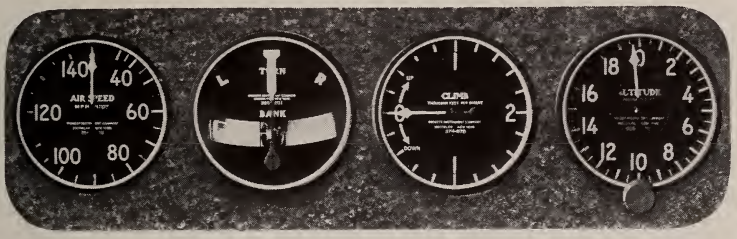

Fig. 2—Correct arrangement of Turn Indicator Group only.

The instruments in Figure 4 are grouped close to each other and arranged on the instrument board so that they can be read quickly when using the Sperry Group or the Turn Indicator Group, giving two separate methods for instrument flying. They are read as follows:

1.—Sperry Horizon and Directional Gyro to maintain level flight and direction.
2.—Altimeter for safe height—*or*

1.—Turn, bank and rate of climb indicators to maintain level flight.
2.—Altimeter for safe height.
3.—Compass for direction.

The airspeed is used to climb or glide by and also for landing.

In illustrations, Figures 3 and 4, it is very easy to check one group with the other or combine the two groups to obtain more information. The Sperry Group and Turn Indicator Group make a board complete and when used correctly, assure a double safety. This combination is much better for comparison, as two groups consisting of the same instruments cannot be combined for any more information than one group would give.

There must be two different groups of instruments because if any instrument goes out of order in one group, another in the other group can be substituted for it.

It is not possible to standardize on one type of board, due to the different types of planes and shapes of boards. It is necessary,

therefore, to arrange the instruments to suit, keeping in mind a standard arrangement of the flight instruments.

For night flying, the proper lighting of the instrument board is obtained best by direct lighting through a rheostat which will regulate the glow of light. When using this system the entire board will receive the same amount of light without shadows.

Indirect lighting is not as satisfactory, as all the instruments are not lighted evenly and when the rheostat is turned low some of the instruments are improperly lighted. This system also requires more bulbs, using up the stored current in the battery, which should be reserved for other purposes, such as landing lights, radio, etc.

Fig. 3—Combination arrangement of Sperry and Turn Indicator Group.

Instrument flying can be done safely with or without passengers, providing the pilot is properly trained and the instruments are properly arranged on the board and he has the two

aforementioned groups of instruments in correct arrangement before him. Operators are beginning to show interest in instrument flying but even yet few pilots have received the proper training in their use.

In the foregoing pages various arrangements of exclusive flight instruments have been shown, but the pilot studying this book will seldom find his ship equipped according to any of them. They are included to show the preferential arrangement for flight instruments, and to provide a basis for such changes in arrangement as are practicable in any given case.

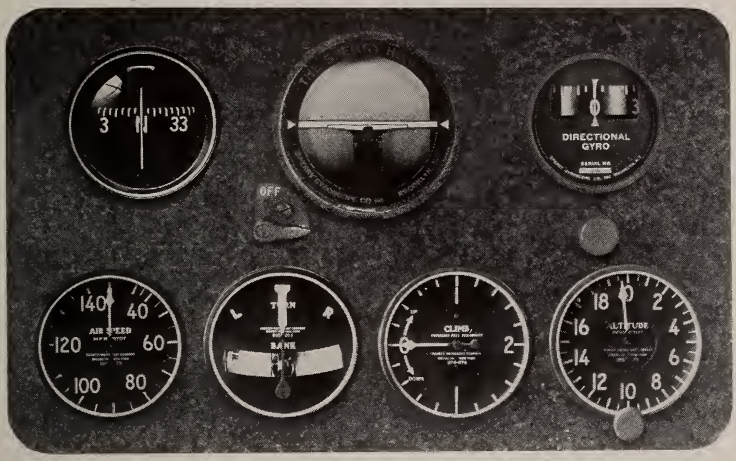

Fig. 4—Another Method of Grouping Sperry and Turn Indicator Systems.

Since the tachometer is not a purely flight instrument, it has not been included in the diagrams, but its importance must not be neglected as it can be used as a check on the airspeed meter in case it freezes up.

The groupings shown have met the approval of a number of competent instrument pilots and should be followed where the instrument boards of the ships permit it to be done.

Many boards at present are confusing, due to the desire of the manufacturer to present a neat, symmetrical appearance, but such dispositions are known as "Fair weather boards" and are a handicap to the pilot who must fly through "soup".

Ease of removal for inspection and repair should be taken into account when designing the instrument board.

The instrument flier prefers to look at the instrument that is right side up for certain information; then refer to the next instrument for further information, in the rotation explained under 1-2-3 Order, or the way the pilot flies when exterior vision is obscured, by first maintaining level flight, then direction and height.

The Sperry Horizon and Directional Gyro

Fig. 5—Sperry Directional Gyro.

THESE two gyroscopic devices are the latest contribution to flight instrument equipment.

They show the position of the plane to the horizontal and whether it is turning, as well as how far it has turned at any moment, and without any lag.

Control movements are instantly reflected in them for the reason that the plane actually moves around their central gyroscopes in response to the controls.

The Horizon shows nose down or up movements and wing down or up movements, *as they occur*, while the Directional Gyro acts exactly the way a compass would if it were solidly tied to the North.

It must be remembered that the latter instrument will wander off the North at the rate of a few degrees per hour, and must therefore be checked against the magnetic compass and re-set at intervals of approximately twenty minutes. This should be done when the compass is not swinging as a result of bumps or turns. The ship should be steadied by the Directional Gyro and when the compass is steady the Directional Gyro setting knob should be used to make them read the same.

In using the Horizon, it must be remembered that it accurately represents the position of the nose with respect to the real Horizon.

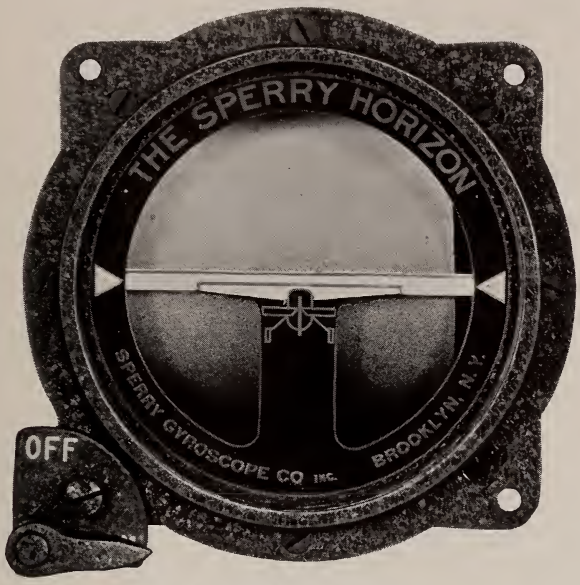

Fig. 6—Sperry Horizon.

The Direct Method of Instrument Flying

The Sperry Group is the direct method of instrument flying because it gives a direct picture of what the plane is doing, and it is possible to turn the reactions used in clear weather directly to account in this case—the reference to climb indicator and airspeed to control pitch angle is frequently necessary even on clear days to maintain level flight, as the altimeter moves too slowly.

To Maintain Straight Flight

In straight flight the miniature airplane in the Sperry Horizon is simply kept parallel with the horizon bar to keep the large plane parallel with the natural horizon and the Directional Gyro centered to maintain a straight course.

NOTE: Since a heavily loaded airplane will fly with the nose higher than the same ship empty, the instrument flyer must realize the bar in the Sperry Horizon will not remain centered. This may be checked against rate of climb indicator and airspeed meter.

Therefore, if the miniature airplane is above or below the bar in level flight, it must be understood that the miniature air-

plane must be centered in the same relationship to the bar when turning.

A Turn

To make a level turn, the miniature airplane is banked right or left, whichever is desired, by using the ailerons. Keep the center of the miniature airplane on the horizon bar by using the elevators or rudder to prevent skidding or slipping. The stick is then pulled back sufficiently to make the turn. Obviously, at this point, too much stick will result in a climb.

To stop the turn, refer to the Directional Gyro and bring the miniature airplane back to level flight with ailerons, at the point on the Directional Gyro which will be on the course.

A Climb or Glide

The minature airplane is kept above the bar to climb, or below for a glide, checking with the climb or airspeed meter for proper rate of climb or glide, and keeping the Directional Gyro centered for the course.

To summarize—when flying by the Sperry Group, the miniature airplane may be handled in reference to the horizon bar, exactly as the large airplane would be in regard to a real visible horizon—the rate of turning being obtained from the Directional Gyro.

From the above, the reader will realize that while it is simple to fly by the Horizon and Directional Gyro alone, a better job can be done if other instruments are also referred to. He can also appreciate that if one of these instruments should go out of commission, the parachute may be the only solution if he lacks the other instruments, or is unable to use them.

A thorough familiarity with the 1-2-3 Order is therefore absolutely essential to the instrument pilot, and he is only *half* a pilot if he allows the greater ease of the newer instruments to lure him into neglecting the others.

Maximum safety demands that he be so familiar with them all that he can still fly with a number of the instruments out of commission, so long as he has the following:

First: —An index of turn.

Second:—An index of level (wings).

Third: —An index of pitch.

The 1-2-3 Order of the Turn Indicator Group

THE following must be absolutely memorized and automatically followed:

First: **Center turn indicator with rudder only.**

Second: **Center ball-bank indicator with ailerons only.**

Third: **Center climb indicator with elevators only.**

On no account attempt to visualize what the plane is doing—you are concerned only with the readings of the instruments. If you attempt to interpret the readings to give you a picture of the plane, you will become confused.

The order in which the instruments are observed is absolutely vital, for the ball-bank will give a false index for level flight if the turn indicator is not centered first of all.

The Turn Indicator
or
No. 1 of the 1-2-3 Order

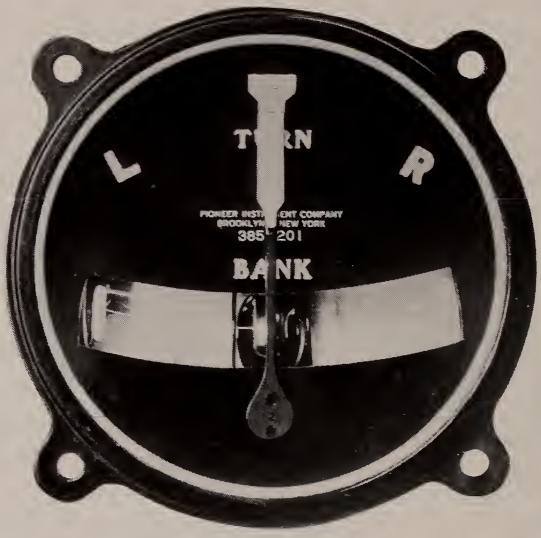

Fig. 7—Pioneer Turn and Bank Indicator.

THE turn indicator is the most important instrument in the Turn Indicator Group. It is placed on the board to show a turn before the compass moves and should be operated only by the rudder. This indicator and the rudder must be considered as one.

The only time a pilot will find difficulty in centering the turn indicator with the rudder, is when the plane is in a tail spin. If the turn indicator cannot be centered, then push the stick forward until the spin is stopped, whereupon the turn indicator hand can be centered with the rudder.

It is a known fact that the plane is going in a straight direction when the turn indicator is centered, even though the pilot may not know the lateral or horizontal position of the plane at the time, having not yet come to the act of checking up the ball-bank and climb indicator. Therefore, the turn indicator is the first step and the foundation on which instrument flying is based. It is always necessary first to center the turn indicator, or see that it is centered. Make this the first step and there will be no

cause for delay or confusion whenever it is desired to fly by instrument.

I find the majority of turn indicators are adjusted too stiffly. A number of pilots favor this, because the hand is then steadier in rough air. It is true that a stiff indicator may work well enough in rough air, as it shows a turn caused by the force or quickness of a movement of the plane, due solely to the rough air, and not by a certain degree turn.

But in quiet air, the stiff turn indicator will not move until the turn becomes sharp. Therefore a stiff turn indicator is of little or no value in quiet air, since it will not detect a turn before the compass starts to swing. In such a situation it is impossible to maintain a straight course while blind by following the compass, as it swings from one side of the course to the other.

The object of instrument flying is to maintain a straight course and avoid loss of time.

The turn indicator must have a sensitive adjustment so that it will show a slow turn in smooth air before the compass starts to swing, thus allowing the pilot to correct for the turn without getting off the course.

In using a sensitive turn indicator in rough air, it is not a question of how far the hand goes off center, as there are only two positions in which the hand of the turn indicator denotes definite information. They are: for straight flight, have the hand centered; for turning, have the hand either to the right or left of center, according to the direction in which the turn is being made. If the hand moves an equal distance back and forth, each side of the center it will give an average reading which is equal to center. But if the hand goes off center and remains off, the pilot knows the plane is turning and the hand must be centered, unless he wishes to turn.

There is no difficulty in using the sensitive turn indicator as it is understood the hand will move more freely due to its sensitive adjustment. It gives quicker and more accurate information.

There is an adjustment screw on each side of the turn indicator. The one on the left side marked with the letter "S" is the sensitive adjustment and it regulates the distance the hand moves from the center for a given turn. The letter "D" marks the adjustment on the right side which dampens or steadies the hand while in movement.

In instrument flying when any difficulty occurs, always center the turn indicator first. Also, be sure it is working correctly before attempting a trip. Do not allow the venturi tubes of the turn indicator, Sperry Horizon or Directional Gyro to freeze up from ice conditions. Arrange to have them heated, if possible.

The Ball-Bank Indicator
or
No. 2 of the 1-2-3 Order

Fig. 8—Ball-Bank Indicator.

EITHER the ball-bank that is in the turn indicator, or a large sized one which can be seen more easily, answers the purpose.

The ball-bank indicator causes more confusion to the pilot than any other instrument on the board, for the reason that it does not give a direct reading. The pilot must refer to the turn indicator first, to see if the plane is in straight flight or turning.

The ball by its own weight remains in the center when flying level, but centrifugal force still keeps it centered while turning. Thus, to gain a correct reading from it, the pilot must read it in conjunction with the turn indicator.

Finally, when the plane is going forward in a straight line, the ball-bank will then denote the correct lateral position of the plane.

When the ball rolls out from the center, it denotes skidding, slipping or that a wing is low. If the plane is skidding the ball will roll out from center in the opposite direction from the turn indicator hand. If the plane is slipping the ball will roll out from center on the same side as the turn indicator hand. When in straight flight the turn indicator hand is centered, and then if the ball rolls out to one side, it denotes that the wing is low on that particular side.

When correcting for the above, the ball-bank indicator must always be centered by the ailerons only. Although the rudder will center the ball it should never be used, as the rudder is for operating the turn indicator only.

The Climb Indicator
or
No. 3 of the 1-2-3 Order

Fig. 9—Pioneer Climb Indicator.

THE climb indicator is used to gauge horizontal flight and is operated by the elevators. The instrument is operated by barometric pressure and this causes it to lag. The plane has to be raised or lowered some distance before the climb indicator will indicate the change. Therefore it cannot indicate an up or down movement of the plane until after such movements are made.

The airspeed and tachometer do not show an up or down movement until the plane has gained or lost considerable speed, therefore, it is seen that they do not act any quicker than the climb indicator, but they can be substituted for the latter instrument if it should go out of order.

The climb indicator is affected by changes of pressure in the cockpit that will cause the hand to move up or down when actually the plane has not moved.

The good feature is that it actually shows when the plane goes up or down, regardless of whether the nose is up as in a stall, or if the nose is down and the plane is being raised by an up current of air.

Some compasses will swing as a result of nose up or down movements and when the compass is being relied upon for direction it is desirable to avoid such movements. When the Sperry Horizon is in use it enables the pilot to avoid these movements.

When the Sperry Horizon is not available, compass swinging as a result of up and down movements of the nose should be neglected, the 1-2-3 Order being followed until level flight has been re-established and the compass has returned to normal.

How to Use the 1-2-3 Order

THE 1-2-3 Order is a process which is used only in instrument flying, and it is necessary for the pilot to have it fixed in his mind in order to know that the plane is in a correct flying position at all times. The pilot must connect the proper instruments to each of the control operations and train his eyes and mind instantly to recognize that the turn indicator is part of the rudder, the ball-bank indicator part of the ailerons, and the climb indicator is part of the elevators.

Of course, while instrument flying has been described in a 1-2-3 Order, it must be understood that all three instruments should be centered in a matter of a few seconds. With time and practice, this correcting as dictated by all three instruments becomes almost simultaneous.

Pilots trained to look in the distance to maintain flight, will find it difficult to read and fly by the instruments since the board is much closer. It will take time to become accustomed to this change, as well as to overcome the feeling of not being level when the instruments indicate that the plane is level.

It does not require any more effort to fly by instruments for a number of hours at a time than it does to fly when one can see the horizon. When the compass is on the course, it is not necessary to watch the instruments, but if the compass moves from the course, the pilot then looks at the turn indicator and goes through the 1-2-3 Order, bringing the compass back on the course.

If the pilot is flying low in thick weather and suddenly goes blind, there should be no delay or confusion in using the instruments. Look in at the turn indicator first and follow the 1-2-3 Order through at a glance. Then read the compass for the course and continue to fly at a safe altitude providing it is known the weather is all right at the destination, otherwise turn at a safe altitude and return to clear weather.

When the pilot has become experienced in the 1-2-3 Order and the weather conditions in which he can fly through, he will have confidence in instrument flying.

Stiff Turn Indicator and a Slow Compass Cannot be Used in Instrument Flying

Many pilots are anxious to learn instrument flying and they read various articles to get the theory. Then when they try to follow out the theory they become confused through the use of a slow compass which prevents keeping a course, or because the stiff turn indicator causes the compass to swing. They then become discouraged and give up the idea of trying to fly by instruments.

DO NOT ATTEMPT instrument flying (blind flight) with a stiff turn indicator or a slow compass. The pilot who tries to fly blind with a stiff turn indicator finds that he is unable to keep a straight course because the compass swings. This is due to the fact that the turn indicator is adjusted so stiff that it does not show a slow turn before the compass shows it. If the turn indicator were more sensitive it would show the slow turn before the compass swings and the pilot could keep the plane on a straight course.

The turn indicators used by the majority of transportation companies throughout the country are adjusted too stiff to be of any advantage in instrument flying.

The compass must be quick and smooth in its action. With a slow acting compass it is very hard to maintain a course, as the compass will not move until the turn has been partly made, then it will swing very rapidly and go on beyond the place where the turn was stopped. By the time the compass quiets down the plane is far off the course. Therefore it is impossible to keep a straight course with a slow acting compass.

A common reason for a slow compass is that the needle becomes blunted from the constant vibration of the plane. The plane will actually turn before any indication is given by the compass. The card will then start quickly and continue on past the point even after the turn has been completed.

Why the Turn Indicator Should be Centered First

In ordinary flight, where the pilot can see the horizon, the plane is kept level by keeping the wings parallel with the horizon, using the ailerons more than the rudder, especially in rough air.

But in blind flight it is necessary FIRST to center the turn indicator with the rudder. When the ball-bank indicator is centered it gives no information without referring to the turn indicator to see if the plane is in straight flight or turning, as in either case the ball-bank remains centered.

The low wing of a banked turn cannot be lifted until the turn indicator is centered, as the ball-bank indicator gives no information as to how much the plane was banked until after the turn indicator is centered.

We will suppose the plane is turning with the ball-bank and climb indicators centered, which makes a perfect banked turn, and the pilot wishes to change to straight flight. He must center the turn indicator with the rudder control. This action will cause the plane to slip and the ball will roll from the center showing which wing is low, then the wing is lifted by the ailerons and when the ball is centered again the correct lateral position has been reached. To avoid slipping, pressure should be put on the ailerons while centering the turn indicator, to keep the ball centered while changing from a turn to straight flight, or from straight flight to a turn. The stick cannot be pulled back until the turn indicator is referred to first. If the plane is turning and the stick is pulled back, it will result in a tight spiral.

To Maintain or Recover Straight Flight

First, if the turn indicator shows that the plane is turning, the turn must be stopped by using the rudder alone, to center the turn indicator.

Second, center the ball in the ball-bank indicator with ailerons to get the correct lateral position.

Third, center the climb indicator with elevators to bring the plane to level flight.

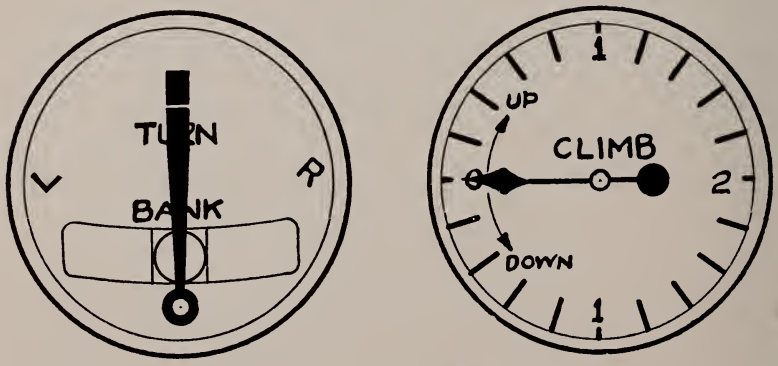

Fig. 10—Straight and Level Flight.

After this process is completed the pilot has time to check the course by the compass and also to observe the other instruments.

A Turn

The turn is started by pushing the rudder first to move the hand in the turn indicator off center a given amount, for instance, the width of the hand, according to how sensitively the turn indicator is adjusted. In rough air, the hand of the turn indicator

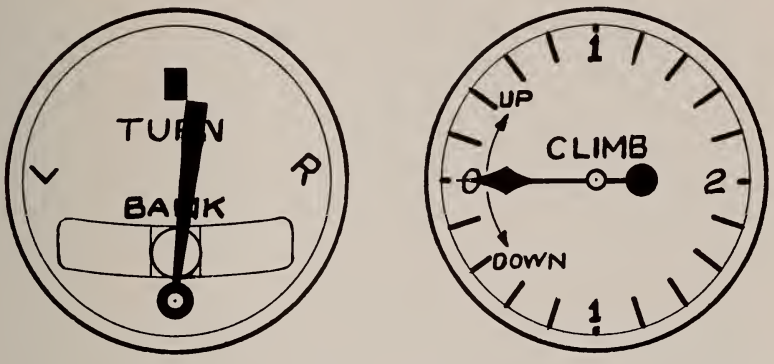

Fig. 11—A Turn.

will oscillate due to its sensitiveness, so therefore an average must be maintained to keep the hand of the turn indicator at the desired distance off center.

Second, keep the ball-bank indicator centered with ailerons, to prevent skidding or slipping, and the result will be a proper bank.

Third, keep the climb indicator centered with elevators to be sure of making a level turn.

It is very important to keep the ball-bank and climb indicators centered while turning as it is very easy to get in a spiral dive. If they get off center and the pilot is not sure of the turn, then he should center the turn indicator and fly straight. Then he is in a position to start another turn.

Care must be taken not to let the hand of the turn indicator go too far from center, as it will result in a steeply banked turn which requires cross control. In a very sharp banked turn, the rudder is used to center the climb indicator, the stick is pulled back to make the turn and the ball-bank indicator is kept centered. Of course, in this case the hand of the turn indicator will go over nearly to the side. Coming out of a turn the procedure is to use the 1-2-3 Order.

In changing from straight flight to a turn, or vice versa, it will be noticed that after the hand of the turn indicator is in its proper place and the pilot tries to center the ball-bank indicator, it will have a tendency to move the hand of the turn indicator out again. In this case merely keep the hand of the turn indicator in its proper place, as it must be operated first in order to center the ball-bank indicator correctly.

The compass will not always follow the turn as fast as it is made, so a good way to know when a turn has been completed is to count the number of seconds it takes to complete a 180-degree turn with the hand of the turn indicator its own width off center. There is no set time as various types of planes vary. Also the adjustment of the turn indicators vary.

After stopping a turn, if the plane is not on the desired course, make a slow turn to get on the desired course as soon as the compass quiets.

A Glide

In descending, slow down the motor, keep turn indicator centered and climb indicator registering not more than 500 feet per minute descent, and watch the AIRSPEED indicator for the proper gliding speed.

If a pilot were several thousand feet up and at his destination, by time and course, he should descend to within 700 or 800 feet of the ground, or less, if this allowance is sufficient to clear all high points in the vicinity, and then fly level to see if the ground

Fig. 12—A Glide.

can be seen through a hole in the clouds. When blind, fly high enough to clear everything safely, as there is no reason for low flying. To prevent guess work and dangerous flying by not having any ceiling at the destination, know what the weather is before the start.

The compass will give the right direction soon after getting in a straight steady glide or climb.

A Climb

In climbing, keep turn indicator centered and climb by the AIRSPEED indicator at the rate of speed the plane will climb most efficiently. Also checking by the climb indicator, climb to a height that will allow at least 500 feet clearance over any high obstacles on the course.

Fig. 13—A Climb.

Compass

It is necessary to have a good compass, one that is quick and smooth in its action.

To fly a straight course blind is the most important part of instrument flying and the hardest to accomplish. The plane will get out of control in rough air if one tries to fly by the indications of the compass, instead of the 1-2-3 Order. The compass is completely unreliable for anything but straight and level flying as it is affected by climbing, gliding, turning and any other movements of the plane. Therefore, the compass should be referred to only when the plane is being flown straight and level.

For a number of years, the turn indicator has been used in connection with the compass to maintain straight flight. This is due to the fact that when in rough air, if the turn indicator is centered the plane will continue to fly straight even though the compass is swinging. The turn indicator must be kept centered until the compass quiets down, then a straight course is maintained.

By the time the climb indicator indicates an up or down movement it will cause the compass to swing even though the plane remains in straight flight on the course. Therefore care must be taken to keep the climb indicator centered before reading the compass.

If the plane is off the course, make a turn as described in "A Turn" toward the desired course, and read the compass after the turn is stopped. Any other turns that are necessary to get the plane on the desired course should be made in the same way.

If the turn indicator has a stiff setting, it becomes more difficult to maintain a course in quiet air than in rough air. If the pilot finds this so, then he knows the turn indicator requires a more sensitive adjustment.

Unstable Planes

Unstable planes can be flown blind with instruments using the 1-2-3 Order. For instance, if the plane is wing heavy the ball will naturally roll to the low side. Therefore, center the ball with ailerons. This will cause the plane to turn slowly, unless enough pressure is kept on the rudder to keep the turn indicator centered.

Multi-Motored Planes Can Be Flown Blind With One Motor Stopped

If one outboard motor stops, the plane will turn toward the side the motor had stopped on, causing the turn indicator hand to swing to that side; the wing will drop a little and the ball will roll from center slightly. The climb indicator will show "down" as the plane slows up from lack of power. In this case the first thing to do is center the turn indicator with the rudder and hold it there by keeping pressure on it, and the ailerons. Keep ball-bank centered, and also keep the climb indicator centered, which will require a little effort as the plane will be inclined to be nose heavy from lack of power. As it will lose from 15 to 20 miles per hour, the stabilizer will have to be adjusted for the

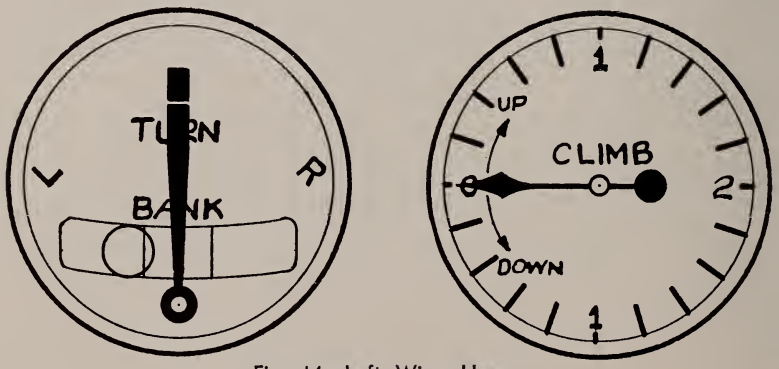

Fig. 14—Left Wing Heavy.

slower speed. Accept the slower flying speed and fly level. Do not nose down to maintain the speed you had before the motor stopped, unless you have a very heavy load and cannot keep from stalling. Keep wing high on side the motor stops. After the plane is adjusted for this condition it will fly by the 1-2-3 Order as easily as before.

A Spiral

FAILURE to center the turn indicator FIRST will cause a spiral which may end in a tail spin.

Planes that get out of control usually go into a spiral dive due to the pilot's lack of knowledge in instrument flying. The

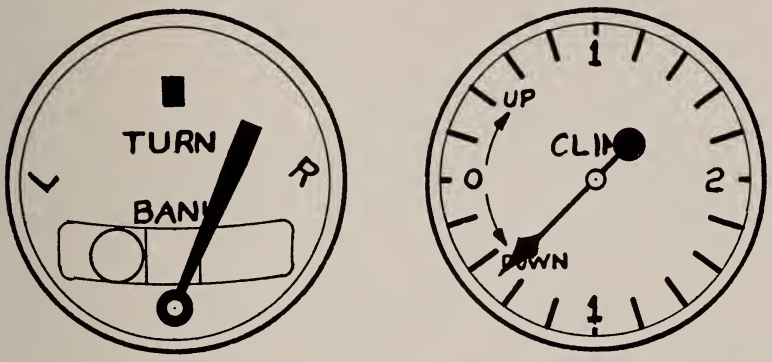

Fig. 15—This Illustration Indicates a Turn, Skidding Out, and Descending.

pilot becomes confused in the use of the ball-bank indicator and the climb indicator, or airspeed, and by not knowing that the turn indicator must be centered FIRST, he has no way of preventing the plane from getting out of control.

Suppose a pilot has made a number of successful trips blind through the use of the compass, the ball-bank and the climb indicator or airspeed and also by the natural stability of the plane. He will gain confidence in blind flying without becoming impressed with the importance of the turn indicator.

Then due to rough air, or in turning, the compass swings and he becomes slightly confused, and in checking over the instruments he sees that the ball-bank indicator is centered, but the climb or airspeed indicates "down". He naturally would then pull back on the stick to try to center the climb or airspeed, believing that the plane was flying level. But in pulling back on the stick he only tightened the turn into a tight spiral or tail spin, which did not center the climb indicator. By not referring to the turn indicator FIRST to see what it indicated, he failed to discover that the plane was turning with the ball-bank centered showing a perfectly banked turn, and with the climb indicator or airspeed slowing down which indicated a perfectly banked spiral. If, see-

ing the increased airspeed and not being able to center the climb indicator by pulling back on the stick, the pilot then pushed the stick forward again, it would only cause the plane to slip, or continue in a dive. Or, if the pilot had noticed that the turn indicator hand was off center and had centered with the rudder, the result would have been the same, a slip. That would throw the ball out and the skidding or slipping by this time would have the pilot greatly confused. If he decides the slipping is a worse condition than he had before he centered the turn indicator, and lets the turn indicator hand go off center again, the result will be that the ball will center again and the plane will continue in the spiral. The pilot's best way out of this difficulty is to bail out with the parachute, as the plane probably will end up on the ground, if there is no ceiling, as it does not take long to lose two or three thousand feet altitude. If he had used the 1-2-3 Order when he discovered the turn indicator was off center, he would have corrected the trouble very easily.

Pilots Should be Instructed

THE absolute necessity of blind flight training for pilots who fly in conditions of no visibility was conclusively demonstrated at Los Angeles Airport by the Professional Pilots Association in a test for instrument flying under the direction of George Vawter, Department of Commerce Inspector. The test was participated in by from 175 to 200 commercial pilots, most of them with transport ratings.

The planes, all with hooded cockpits, were equipped with turn, bank and climb indicators, compass, altimeter, and one of the planes had a Sperry Horizon. It was found that none of the pilots, except a few who had had some blind flight training, could maintain a straight course for any length of time. Within five minutes they would go into a tight spiral, ending in a spin. The percentage of men who failed this test should go a long way toward convincing pilots and operation managers that it is absolutely necessary to train the pilots to fly by instruments for safer flying. Several accidents have occurred with passengers aboard when flying in a condition of poor visibility, for no other reason than that the pilot did not know how to fly by instruments.

The majority of Army and Navy pilots, who are now flying commercially, were not trained to fly blind by instruments during their period in the service.

It is no fault of the pilots that they lack experience in instrument flying as it has and still is almost impossible for the average

pilot to get the proper information and training necessary for instrument flying.

Several companies have attempted to give instructions in instrument flying by using a dual controlled plane with one cockpit open for the instructor and the other cockpit covered for the student, and using a speaking tube to communicate.

Therefore, the student is not flying blind, as he is seeing through the eyes of the instructor, and the instructor tells him the position of the plane when it is not in normal flight, and then the student corrects it. This information is of no more value to the student than if he practiced flying alone in an open ship and by his own will kept his head inside the cockpit, looking out only when he could not keep the instruments centered. This gives him the same information as the instructor gives by telling him the position of the plane. This method does not give satisfactory results, as it is very necessary that the instructor teach the student from the instruments.

To teach instrument flying properly, it is necessary FIRST to select an instructor who knows instrument flying perfectly, and SECOND, to obtain a plane along the type of a Stinson Junior blinded and with dual control, so that the instructor and student sit beside each other and use the same instrument board.

Then the instructor is in a position to teach the student from the instruments, and also will be able actually to show him his mistakes on the instruments and how to correct them properly. The student will have more confidence and learn much faster by having the instructor beside him, as he knows that they are both flying blind under the same conditions, as he alone would be expected to fly.

There is much to learn from actual practice in flight with the instructor. Getting the theory and being able to fly by instruments in quiet air is only the first part of the instruction. The final instruction should be given when in the clouds and in very rough air, as it is very difficult to maintain a straight course while blind under these conditions, unless thoroughly instructed.

To avoid flying into another plane, a student or person could sit in the back seat to watch out of the back windows, which have no curtains. He could tell the instructor when another plane is approaching. Or, if desired, a curtain could be placed between the student and the instructor, keeping the student blind and allowing the instructor to see out of the plane.

It is not necessary to use the Sperry Group for training purposes as the proper method for training is the Turn Indicator Group (the 1-2-3 Order). When a pilot has been properly trained by this method, he finds he is quite capable, and uses the Sperry Group without any difficulty.

The radio beacon is a great aid to instrument flying as it gives a correct course when blind and with the blind landing instrument now being developed by the Government it will become safe to land blind. It must be realized that before one can use either the radio beacon or the new blind landing instrument, it is necessary to know instrument flying perfectly.

A pilot, by reading this book, will gain valuable facts on instrument flying, but this book will not teach instrument flying any more than a book on "How to Fly" would teach an uninstructed person to become a pilot.

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NOTE—Aviation Schools and Students.

I wish to correct the statement in regards to giving instructions only in a dual plane with the instructor and student sitting beside each other.

I wrote this with only one idea in mind and that was instructing pilots on Transport Lines and to secure a position to give instructions. Therefore, this point was stressed too much, making it rather one-sided. This is merely one method for teaching instrument flying.

Giving instructions in a dual-controlled plane with one cockpit open for the instructor and the other cockpit covered for the student, and using a tube to communicate, can be done equally as well providing the instructor corrects the student by referring to the instruments instead of giving the position of the plane.

Of course, the plane available must be considered, otherwise the cost of the instruction would be increased.

HOWARD C. STARK.


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