aerial navigation

chapter 13

Aerial navigation is the art of flying an aircraft from one point to another and determining its position at any time along the route. Up to this point you have devoted all of your time in training to practicing maneuvers which developed your ability to control the aircraft in all flight attitudes. In developing this skill, you have had little chance to appreciate the aircraft as a means of transportation. Since flying from one place to another is an important part of almost any mission you will accomplish later on, the cross-country flying that you will do in primary flying will be valuable training and will give you the fundamentals of aerial navigation. You will have the opportunity to work practical problems in navigation and to apply the knowledge you have acquired in the classroom.

Prior to both your first day and night navigation flights, you will be given a dual familiarization ride. The day familiarization flight will come first. During the ride your instructor will show you how to identify check points, compute ground speed, and make off-course corrections. He will also give you a chance to navigate so that he can check your proficiency prior to your first solo navigation flight. The purpose of the night familiarization flight will be to show you the difference in appearance of the check points during the day and night and to demonstrate the difference in technique employed.

PREPARATION FOR A NAVIGATION FLIGHT

There are many factors to consider in preparation for a navigation flight. These factors will vary, moreover, with the conditions under which the flight is to be conducted. For instance, you have to prepare differently for a day navigation flight than you do for a night navigation flight. The weather, terrain, range, landing and fueling facilities, and frequency of check points along the proposed route will also influence your preparation.

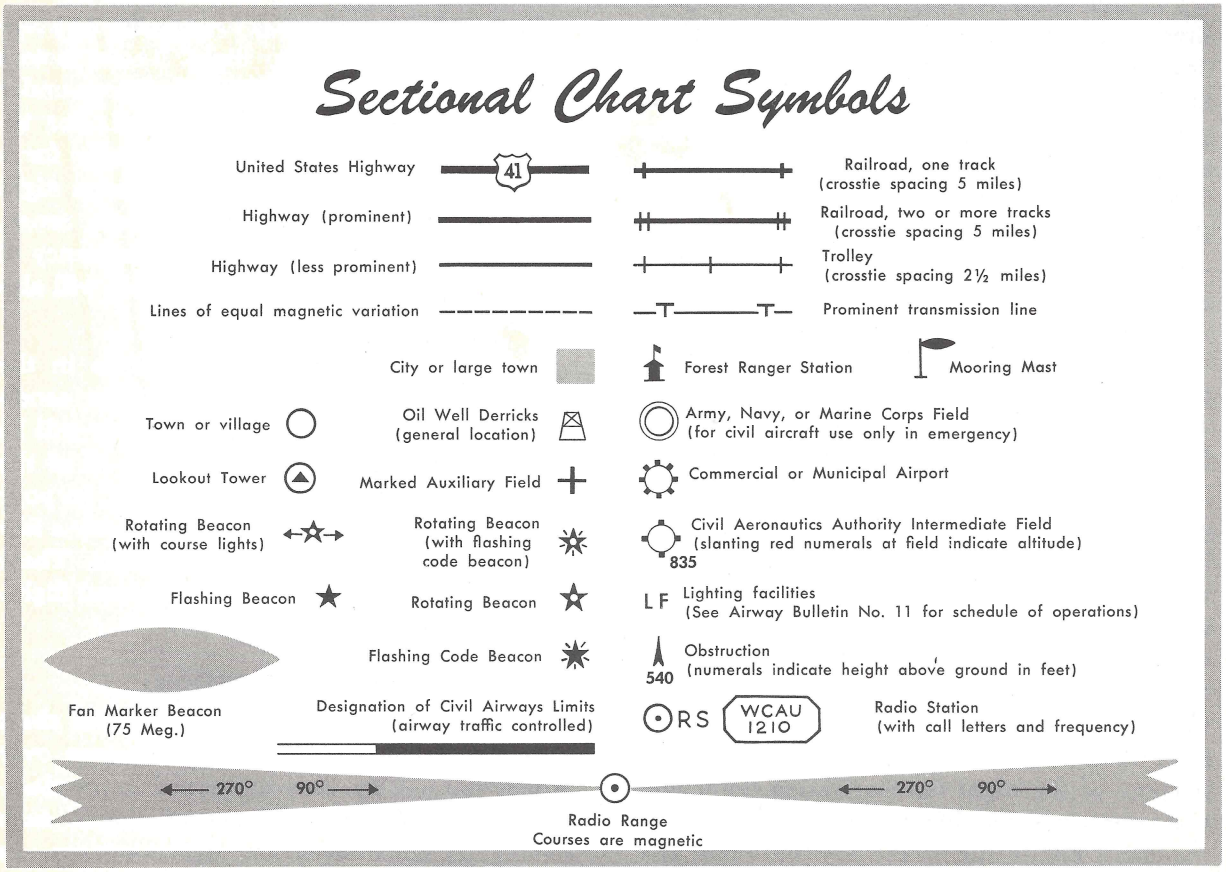
Your first navigation flight will be in the daytime and under favorable weather conditions. Much of your pre-flight planning will be done for you. Later on, you will do all of the planning and preparation yourself, but, for your first navigation flight, you will have only a few necessary fundamental considerations. These are chart preparation, route survey, and flight-log preparation.

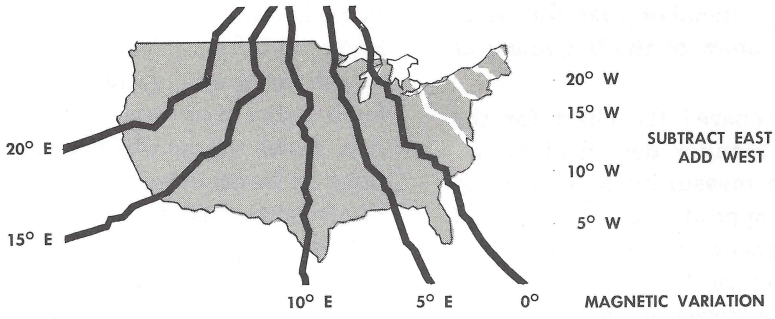
CHART PREPARATION

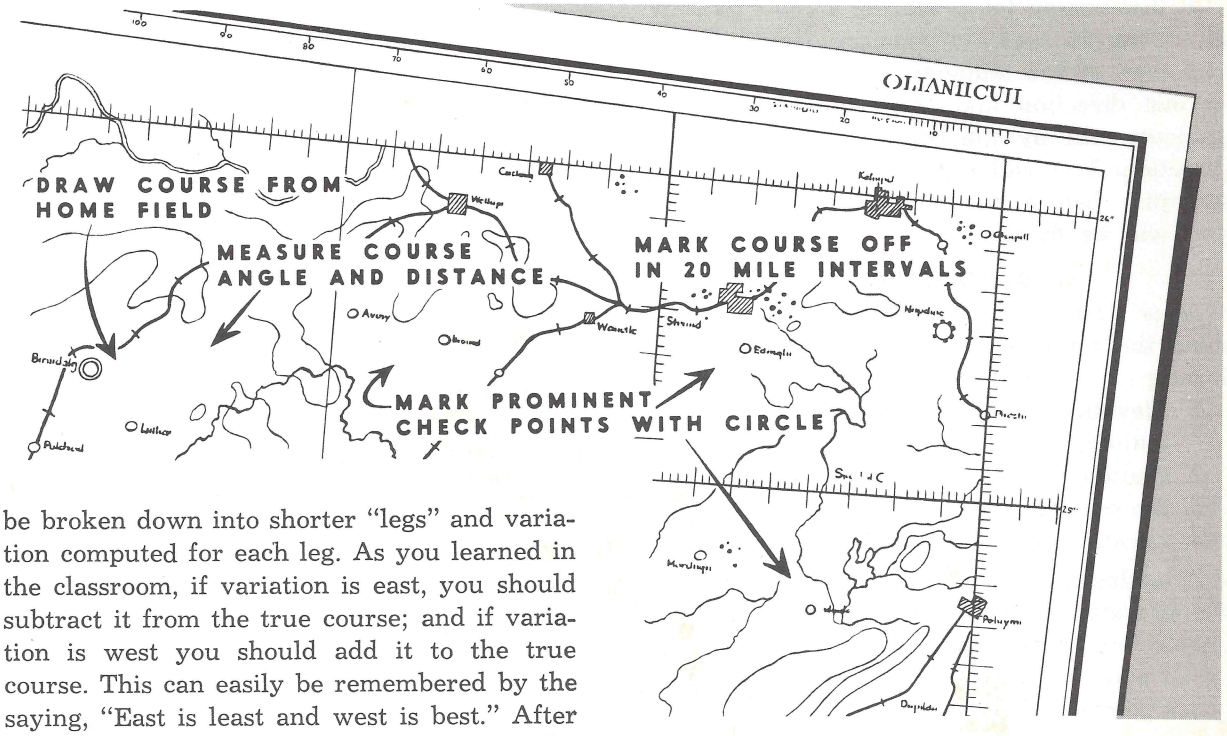
The very first step in preparing the chart is to select one which includes the area over which you will fly. As you learned in the classroom, there are many types of charts, each having its advantages and disadvantages. In

your primary flying training, the Sectional Chart will be used because of the relatively short distances you will be flying and also because the main supporting type of navigation will be pilotage. The large scale of the Sectional Chart makes it more appropriate for pilotage techniques. Since a given area of the chart represents a relatively small portion of the ground, considerably more detail is shown on the chart.

After you have selected the proper chart, the next step is to draw the course line from the point of departure to the point of destination on the chart and determine the true course and distance. The course line can be drawn with either black or colored pencil. The important thing is to make sure that it can be easily seen. True course, as you know, is the angular distance from true north to the course line, measured in a clockwise direction. It is determined by measuring the angle between the mid-meridian (the meridian lying closest to the mid-point of your course) and the course line. The mid-meridian is used because each meridian converges toward true north on the Lambert Conformal Chart and consequently will form a different angle with the course line. To fly an exact true course, you would have to change heading constantly. Since this would be inconvenient, you can fly an average true course measured from the mid-meridian and any errors involved will tend to cancel out. Now you should apply variation to the true course to find magnetic course. This is done by reading the variation at the end of the isogonic line which passes through the middle of the course. Actually, variation changes gradually as you fly from one place to another. To mid-variation line as long as the flight is in the same general area. Later on, when your flights extend over longer distances, the course will







Marking Your Map

be broken down into shorter "legs" and variation computed for each leg. As you learned in the classroom, if variation is east, you should subtract it from the true course; and if variation is west you should add it to the true course. This can easily be remembered by the saying, "East is least and west is best." After you have applied this correction, write the magnetic course in large numbers on the right side of the course line and indicate the direction of the course by means of an arrow. Now measure the length of the course. This can be done by using the appropriate scale on either the Weems plotter or the bottom of the chart. You should be careful to use the statute-mile scale if you are using statute measurement and the nautical scale if you are using nautical measurement. At any rate, all factors used should be expressed in terms of a common measurement. After you have determined the distance of the course line, you should write the distance directly below the magnetic course that you have just written on the chart. The next step is to place a small pencil mark to the right side and perpendicular to the course line at each ten-mile interval. At each twenty-mile interval you should write in the total distance to that point on the course line, that is, 20, 40, 60, and so forth.

You have now completed your chart for the first leg of your flight. Do the same thing for

the remaining legs. Remember that the mileage should be begun anew at the beginning of each leg.

After you have prepared the chart for the entire flight, in the manner described above, start over, this time measuring and marking the courses in the opposite direction. Label the courses and mileages on the right side of the course line as before. Since you are now going in the opposite direction, however, the data will be on the opposite side of the course line. The reason for preparing a chart in both directions is that, in primary flying training, part of the students will fly the course in one direction and the remainder of the students will fly the course in the opposite direction. You will not know until the briefing just before the flight which direction you will be flying.

ROUTE SURVEY

After you have completed the chart, examine the route very carefully. Note the following:

1. Elevation of terrain (with particular attention to hills or peaks)
2. Caution, danger, and prohibited areas
3. Emergency landing fields
4. Location and frequency of check points

A landmark used to establish the position of the aircraft is called a check point. It will also enable you, during flight, to compute ground speed and arrival time quickly and easily. A check point should be a unique feature or group of features along or close to your course. A landmark such as a large lake, although a very good reference in itself, would be a poor check point. A town at one corner of the lake, however, with an identifying highway or other feature would be an excellent check point.

The type of check point used will vary with the type of terrain over which you are flying. In open areas or farm country, almost any town or any combination of railroads or roads may be used. A railroad by itself, again, is a good reference point; but, to be a good check point, it would have to have some identifying feature to tell you at what position along the railroad you are. In more densely populated areas, such minor features as small towns close to similar towns, secondary highways, and so forth make poor check points. In such areas it is easier to identify principal highway junctions or large cities with distinctive shapes. A single large city or town itself would provide definite identification, and some prominent feature such as an airport or race track would indicate your exact position. Sometimes, when the only available check points are several towns of approximately the same size, they may be distinguished by comparing the pattern of roads and railroads leaving the towns. There will be the possibility, however, that the check point you have chosen will be mistaken for some other group of similar features. If this is the case, position identification may sometimes be made by continuing on course and checking another reference point that will positively identify the check point. In forested areas the swaths cut for pipe lines or power lines can serve as good reference lines. In mountainous areas mines, ranger stations,, peaks, and passes may be used. In deserts, where check points are few, such minor features as ranches or houses may be used.

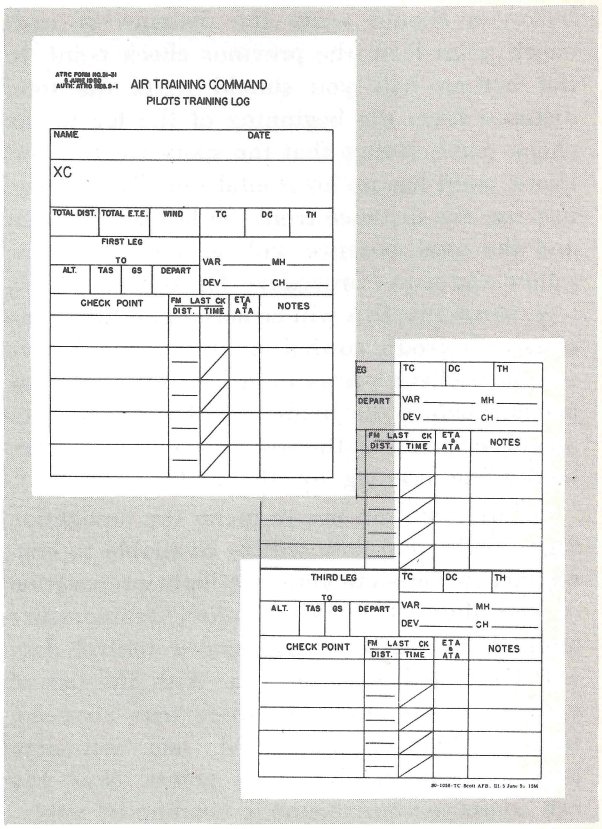
The check points generally should not be more than fifteen minutes' flying time apart. Sometimes the nature of the terrain will make the distance greater. The value of having check points close together is that corrections can be made before you fly too far off course.

After you have selected your check points, mark each one by drawing a circle around it so that it can be easily found on the chart during flight.

THE FLIGHT LOG

The next step in preparing for the flight is to fill out the flight log. The flight log is a record of all courses, headings, distances, speeds, check points, and other data important to the successful completion of the flight. It provides you with an organized record and schedule for the flight, thereby minimizing the possibility of forgetting important data and having to compute many problems in the air.

There are many forms of flight logs, each designed for a particular purpose. The flight log that you will use in primary flying will be an abbreviated version of the type of log which you will use later in training. It lists only information which is fundamental to a navigation flight. The flight log which you will use is illustrated to the right. Note the information it contains.


AIR TRAINING COMMAND
PILOTS TRAINING LOG

NAME DATE

XC

TOTAL DIST. | TOTAL E.T.E. | WIND | TC | DC | TH

FIRST LEG

TO

ALT. | TAS | GS | DEPART | VAR ____ MH ____ DEV ____ CH ____

CHECK POINT | FM LAST CK DIST. | TIME | ETA A ATA | NOTES

THIRD LEG

TO

ALT. | TAS | GS | DEPART | TC | DC | TH | VAR ____ MH ____ DEV ____ CH ____

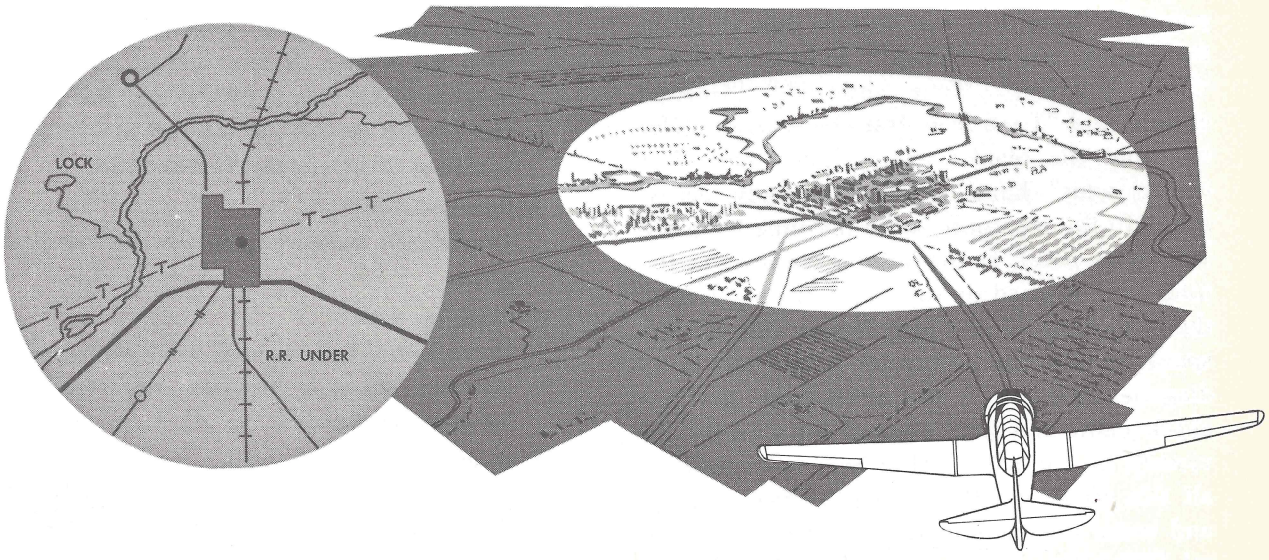
CHECK POINT | FM LAST CK DIST. | TIME | ETA A ATA | NOTES

Flight Log

PREPARING THE FLIGHT LOG

First enter your name, the date, and the navigation flight to be flown. Then enter the total distance and true courses as measured on your chart. Now enter in the space provided the variation that you previously found for each leg. Remember that wind speed is usually given in knots. If this is the case, it will be necessary for you to change the wind speed from knots to miles per hour, since your airspeed will be in miles per hour. This can readily be done with your computer.

The next step is to fill in all the data pertinent to the navigation flight. Write in the spaces provided the names of all of your check points in their proper order. Now fill in the column labeled "Distance from last check point." Notice there is a horizontal line dividing each space into equal halves. In the top



Is That The Town

half you should write the distance of each check point from the previous check point. In the bottom half you should write the total distance from the beginning of the leg to the check point. Notice that the space for the first check point has no horizontal line. This is true because the distance from the last check point and the total distance will be the same. Now follow the same procedure for the remaining legs. Normally, this will be accomplished by the class as a group, so that all students will have the same check points in order to simplify the briefing before the flight. You have now completed as much of the log as you can prepare before the briefing for the flight.

On the day you are to make the navigation flight, additional data will be available to enable you to complete your pre-flight preparation of the flight log. Winds aloft, temperature aloft, flight altitudes, and cruise control data will be posted for your use. With the use of your E-6B computer, calculate true airspeed, true heading ground speed, and estimated time en route to the check points. Now you can compute your magnetic heading by applying variation to the true heading. This correction is made in the same manner as you corrected true course for variation. Remember: "East is least and west is best." Enter the magnetic headings in the space provided. After you have done this, you will be able to fill in the blanks labeled "Wind," "Drift correction," "True heading," "True airspeed," "Ground speed," and "Time from last check point." Notice that the blanks under "Time from last check point" have a line diagonally across them. In the top space write the time from the last check point; in the bottom space enter the total time elapsed or the time consumed from the beginning of the leg. Notice that in the space opposite the first check point there is no diagonal line, since the time from the last check point and total elapsed time would obviously be the same. After you have entered all this data, add the total time for each leg and enter this time in the blank labeled "Total ETE." This is the total time you expect to fly on the navigation phase of the flight; that is, excluding take-off and landing.

Now check your log. The only blanks you should have are those for deviation, compass heading, departure time, and the columns labeled "ETA," "ATA," and "Notes." These will be filled out after you go to the aircraft and during flight.

PRE-FLIGHT BRIEFING

Just prior to the flight there will be a briefing of all students. The purpose of the briefing is to tell you just what will be done and how it is to be done. The briefing will include all of the pertinent data necessary for the successful completion of the flight, and it will give you the opportunity to check your own computations. It will also include any information peculiar to your primary flying school. Not all of the data that will be contained in the briefing can be written down in a set of rules; however, all briefings will cover the following main points:

1. ***Aircraft assignment and take-off interval for each student:***
   Take-off interval will be expressed with reference to H hour. For example, the first aircraft will take off at H hour, the second aircraft at H plus two, the third aircraft at H plus four, and so on. Later on, either during the briefing or after the briefing, H hour will be announced. Suppose that H hour is 0930 hours. This means that the first aircraft will take off at 0930, the second at 0932, and the third at 0934.
2. ***Route briefing:***
   Check points and danger, caution and restricted areas.
3. ***Flight-log data:***
   Cruise control, true airspeed, winds aloft, speeds, variation, magnetic headings, estimated time between check points.
4. ***Weather:***
   Forecast weather and weather along route.

After all the information has been covered, the briefing officer will ask whether there are

any questions. If there is anything that is not clear in your mind, *now* is the time to ask about it. Do not start cross country with any unanswered questions in your mind.

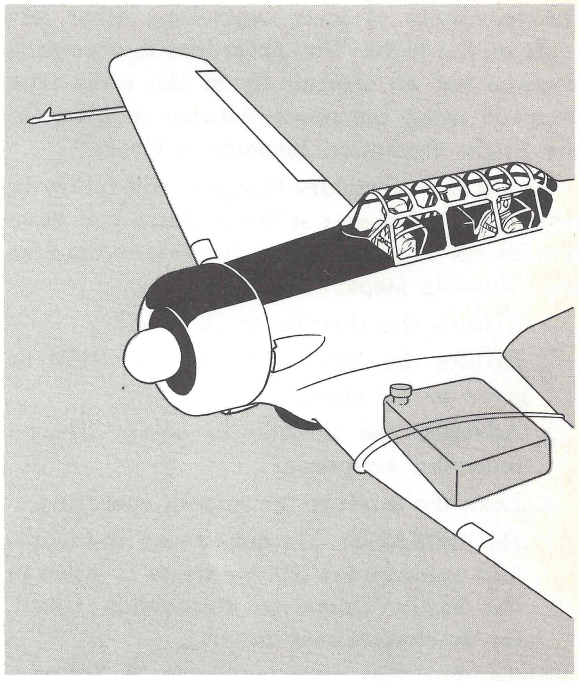
When all questions have been answered, the briefing will be concluded. At this time your instructor will check your charts and log computations to make sure that you have properly completed all the details. He will also answer any last-minute questions you may have.

CRUISE CONTROL

Cruise control means the employment of methods to secure the efficient operation of an aircraft. On a navigation flight it can mean the difference between successful completion of the flight and ending the flight in disaster. Cruise control also saves valuable gasoline and increases engine life. You will use cruise-control procedure on all of your navigation flights.

Cruise-control data for any aircraft will be found in the "Pilot's Operating Instructions Handbook" for that aircraft. Since these charts will be used on all navigation flights from now on, you will use them, beginning with your first flight. Although the compiling of these charts is quite complicated and involves various tables and operation curves, the actual use of them is relatively simple.

Let's take a sample problem. Suppose you are flying a T-6D aircraft with a gross weight of 5,250 lbs., and your assigned altitude is 6000 feet. Also assume that you want to get maximum range out of the aircraft. Now consult the "Maximum Air Range" column in the Flight Operation Instruction Chart for the gross weight closest to the gross weight of your aircraft. Notice that altitude is given as pressure altitude. Technically, this is correct; however, there is little difference between indicated altitude and pressure altitude. For practical purposes, therefore, you can simply use indicated altitude. In this case, your indicated altitude will be 6000 feet. The closest altitude on the chart to 6000 feet is 5000 feet. Thus read opposite 5000 feet to get the power setings, fuel consumption, and true airspeed. You will find these settings: RPM 1600, manifold pressure 26″ Hg, mixture lean, and fuel consumption 23 GPH. Notice that the chart gives 155 MPH as the true airspeed. This is the airspeed that you will probably have. If you do not have this airspeed, however, you should not change your power setting to obtain it. It is as simple as that.



Conserve Your Fuel. Practice Cruise Control

Later on, you will get practice in computing your fuel consumption on your flight log. In primary flying, however, you will just fly the power setting which will give you maximum range.

In your primary flying navigation flights there will be one minor variation from the usual cruise-control procedure: you will not use the manifold pressure as given in the chart, but will use sufficient manifold pressure to give you a certain indicated airspeed. This indicated airspeed will be given during the pre-flight briefing. This is done so that all students will be flying at the same speed and, consequently, the ETE's will be the same. This will make it much simpler to check your flight log during the pre-flight briefing. Also, it will minimize

the possibility of your overtaking other aircraft on the flight. This procedure is necessary because not all aircraft fly at the same true airspeed using the power settings as given in the Flight Operation Instruction Chart.

This is the procedure that you will follow in setting up the power settings. After you have leveled off at your flight altitude, accomplish the following steps:

1. Reduce the throttle to 20″ Hg.
2. Reduce the RPM to the proper RPM as given in the chart.
3. Advance the throttle to obtain desired indicated airspeed.
4. Lean the mixture for smooth operation.

   IMPORTANT: Do not exceed the manifold pressure for RPM settings as given in the Flight Operation Instruction Chart, for detonation may occur.

Remember that after a change of altitude, you must re-accomplish the steps listed above.

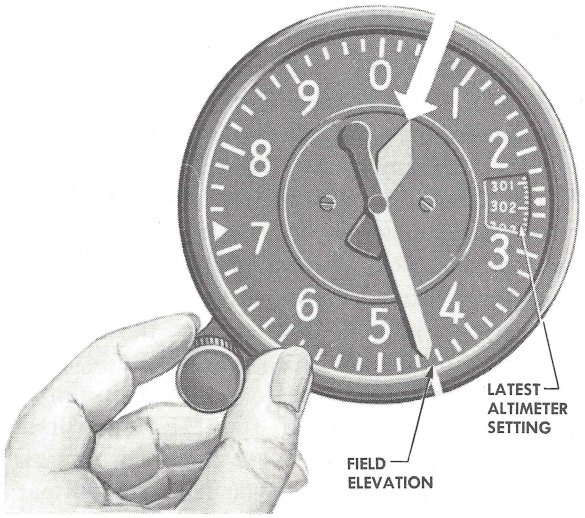
THE FLIGHT

You are now ready to begin the navigation flight. Before you go out to your aircraft, make sure that you have the following items: charts, flight log, Weems plotter, E-6B computer, and a pencil. When you get to the aircraft, go through your regular inspection and checks, paying particular attention to the fuel tanks. If the fuel tanks are not full, ask one of the mechanics to "top" the tanks. Never take off with tanks that are not completely full. In an emergency, that extra ten gallons may mean the difference between landing safely and landing short of the runway. After you are in the cockpit and have completed the normal checks, note the correction necessary for deviation as recorded on the deviation card for each of your magnetic headings. Write these corrections in the proper blanks on your flight log. Now apply these corrections to the magnetic headings and write in the compass headings in the proper spaces. These are the headings that your magnetic compass should indicate when you are flying in the proper direction.

SETTING COURSE

You are now ready to taxi out and take off. You should allow plenty of time in your planning to enable you to take off at your previously assigned take-off time. Needless to say, if any student took off whenever he pleased, there would be considerable confusion. Before take-off, be sure to set your altimeter at the field elevation. Later in your training you will put the altimeter setting in the Kollsman dial and check the hands for field elevation. When you do this, the maximum allowable error is 75 feet. The advantage of using this method is that when you call in for landing instructions, either on return to your home base or on arrival at another field, the tower will give you a new altimeter setting. This new altimeter setting will adjust your altimeter for the new pressure at your destination. When you land, the altimeter will indicate field elevation.

After you have climbed to your flight altitude, fly over the field on your first heading. This is called "setting course." Note the time that you set course and write this time in the space labeled "D." Before setting course, you should have accomplished your cruise-control procedure and have attained the proper indicated airspeed. The reason for setting course



Have Your Altimeter Set Correctly

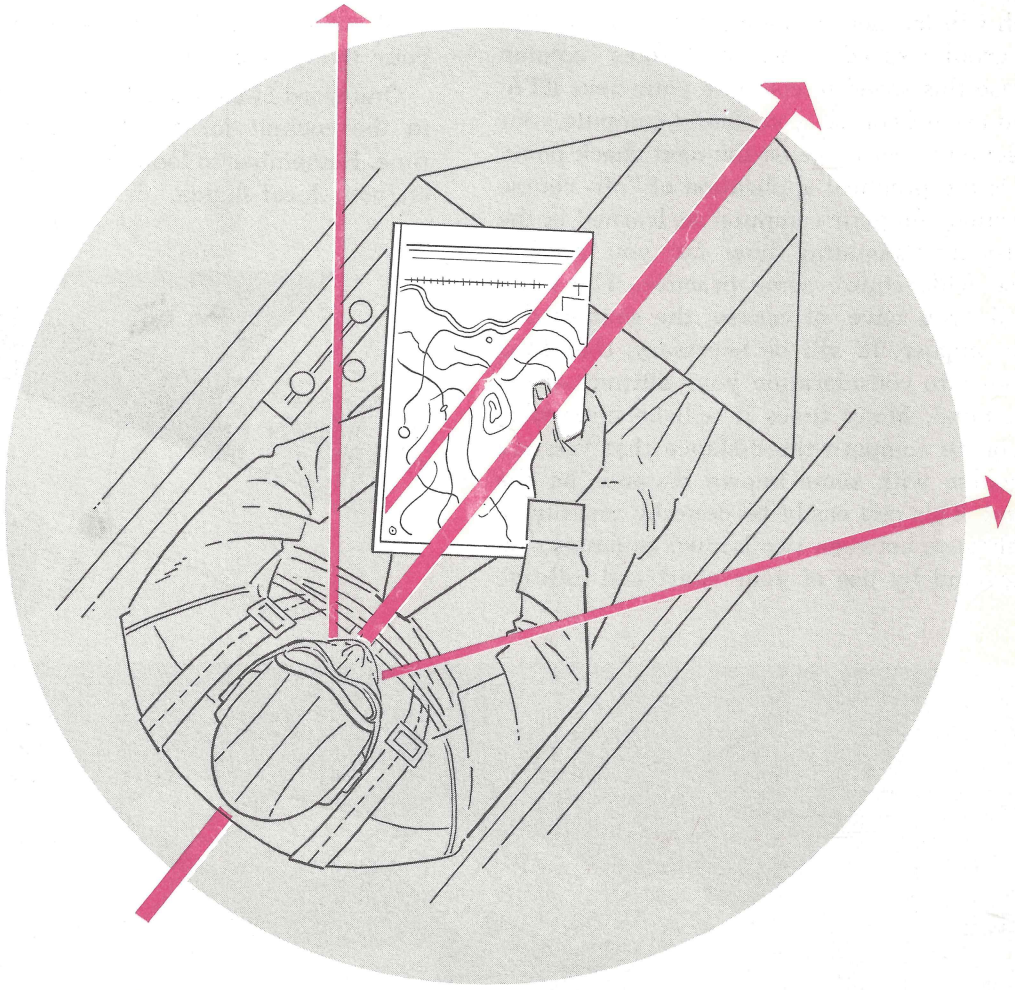
directly over the field and at your proper altitude is that your time en route computations will be more accurate. Later on, when you are more familiar with navigation techniques, it will not be necessary for you to climb to your altitude before setting course; you will climb on course instead. The slower airspeed used for the climb will be computed on the log.

IN-FLIGHT PROCEDURE

Now that you are on course, it is very important for you to maintain your proper heading. By doing this, you will get a fairly accurate check on both heading and ground speed when you reach the first check point.

As you continue on course, you will want to check your progress over the ground by referring to the chart. The easiest and most convenient way to use the chart is to have it folded neatly, with only the particular area over which you are flying exposed. Align the chart so that the course line on the chart lies in the same direction as your aircraft is headed. In this manner your check points and other landmarks will appear on the ground in the same relative position as they do on the chart.

During the time it takes you to reach your first check point, you can bring your flight log up to date. Draw a diagonal line across the space in the column labeled "ETA" and "ATA"

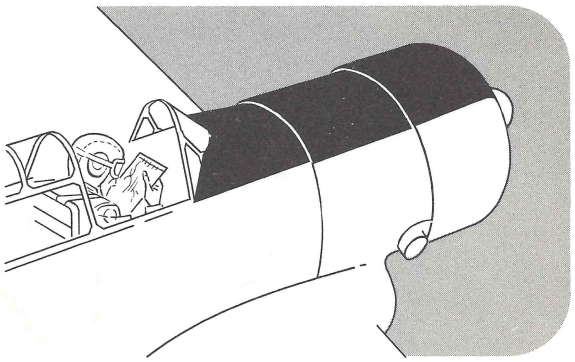


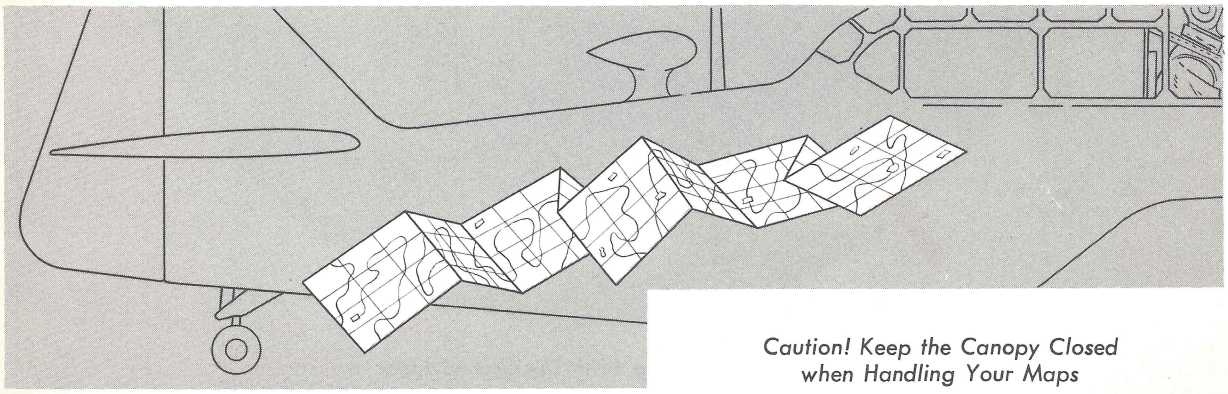
Line Your Map Up With The Ground Track

(estimated time of arrival and actual time of arrival). Now add the time under the column "Time from last check point" to the time of setting course and enter this in the top space of "ETA" space. When you arrive at the first check point, note the time and enter it in the bottom space of "ATA" space. If every factor has been accurate and your computations correct, these two figures will be the same. In actual practice, however, your winds aloft information will probably be in error, and a slight correction will be necessary. If the actual time of arrival is not the same as the estimated time of arrival, it will be necessary to recompute the ground speed with your computer, using the time, rate, and distance method which you learned in the classroom. Enter this new ground speed under the "Notes" column and use this speed to compute your next ETA. If you are off course, you should compute your correction to converge on the next check point. This is the practical application of "off- course correction" on your computer as learned in the classroom. Estimating how far you are off course will require some practice. The more altitude you have, of course, the smaller distances appear. It will be necessary, therefore, to take into consideration your altitude above the ground. Many times it will be impossible for you to compare the distance that you are off course with some known distance on the ground. This can easily be done by measuring the distance between two known landmarks on the ground by use of your chart and mileage scale. Care should be taken, however, that your time checks are accurate and that you have maintained your heading. If you fail to hold your heading or do not record your time correctly, you cannot expect your new correction and ground speed computation to be accurate. Now do the same thing at your next check point. If your latest off-course correction and ground speed computation have been accurate, you will arrive at the next check point on your ETA; and you will be on course when you get there. The only thing you will have to do then is take up your new heading or heading to parallel.

The same method is to be followed for the rest of the flight. This procedure will be covered more thoroughly in the classroom and by your flying instructor.

One word of caution: Do not keep your head in the cockpit for too long a period at one time. Remember to look around just as you did on your local flights.

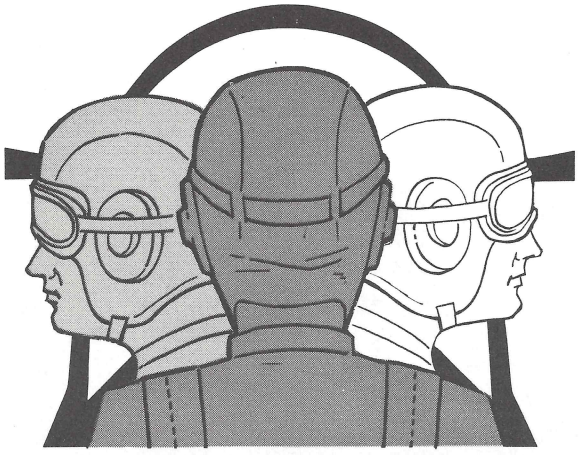




Caution! Keep the Canopy Closed when Handling Your Maps

LOSS OF CHARTS IN FLIGHT

Most pilots find out at one time or another that if the canopy is opened when the charts are spread out in the cockpit, there is a great possibility that they will be sucked out into the slipstream. Be very careful, therefore, to put your charts away whenever you have occasion to open the cockpit. Another precaution is never to spread them out all over the cockpit; instead keep them folded neatly with only the portion that you are using visible. If they do happen to blow out as a result of carelessness, however, you will be forced to rely on your flight log. For this reason it is a good idea to get a good mental picture of your entire flight before take-off. If charts are lost during the first part of the flight, the best procedure is to make a 180° turn and return to the home base. If they blow out after you have flown more than half way around the course, however, it is just as well to continue on course, paying particular attention to headings, ETA's, and your flight log. Later on you will learn to use other facilities, such as the Radio Facility Chart; but in primary flying you will have to rely upon your memory and flight log.



Look Around

STRANGE-FIELD LANDINGS

On one of your navigation flights you will make a landing at a field other than your home base. This is called a strange-field landing. The reason for practicing strange-field landings is that later on many of the landings you make will be at strange fields. Before landing at a strange field, you should be thoroughly familiar with ll the pertinent information regarding the field. You will be concerned with length and width of runways, type of runway surface, direction of runways, elevation of the field, landing hazards, and obstacles in the vicinity of the field. After you are graduated from flying training, you will have to find all of this information for yourself from the appropriate publications. During primary training, however, all of this will be done for you. You will be told all the necessary information during the briefing just before the flight.

When you arrive at the field, you should circle it and locate all obstacles and hazards. After you feel sure that you are familiar with the field, call the tower for landing instructions, using the procedure explained during the briefing. Make a normal traffic pattern and landing. Remember, however, that the elevation of this field will probably be different from that of your home base. For this reason, your traffic-pattern attitude will vary accordingly. After your landing, you will taxi back, take off, and continue on your flight.

You have just completed your first day navigation flight. From now on you will be making more and more navigation flights, some of which will be at night. But remember that although each flight will be different in specific details, the same fundamentals that you have just learned will apply to every navigational flight you will make.

NIGHT NAVIGATION

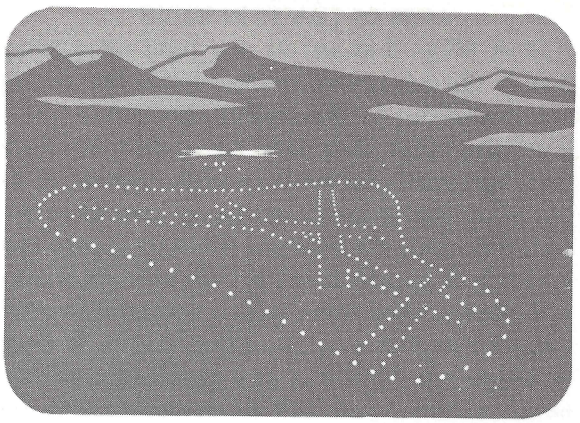
Sometime after you have made your first day navigation flight, you will be scheduled for a night navigation flight. On the night navigation flight you will combine the techniques and procedures that you have learned during the day navigation flight and night flying. Basic-

ally, the preparation for the flight and its accomplishment will be the same. There will be, however, several differences of which you should be aware.

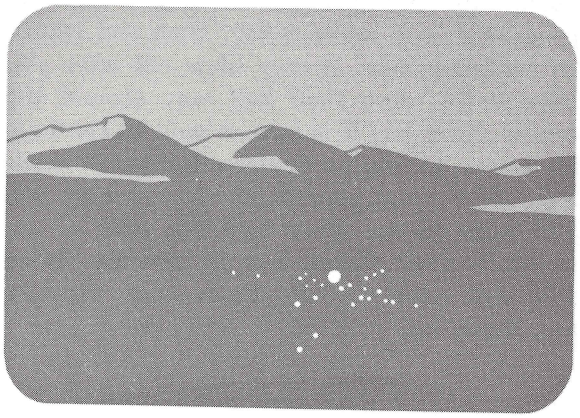
First of all, when you are preparing for a night navigation flight, it is advisable not to mark charts with a red pencil. As you know, when flying at night, you should use a red light in the cockpit, because a red light will not affect your night vision. If you use a red pencil to mark charts, you will find the course line under the red light will be almost invisible. You should, therefore, draw in your course line for night flights with a blue or black pencil.

For your night navigation flight it will also be necessary for you to add one item to your personal equipment checklist. That is a workable flashlight. A flashlight will provide a means of checking your instruments and maps in the event of electrical failure on your aircraft.

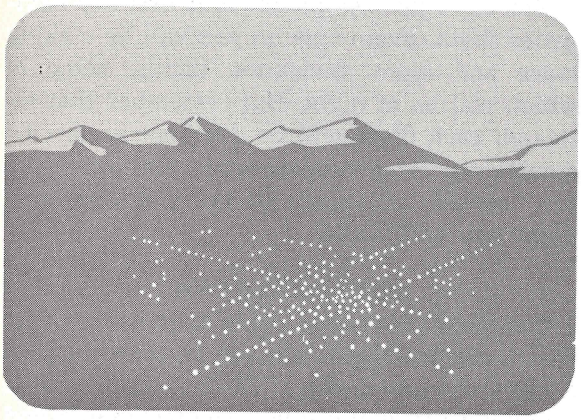
The biggest difference between day and night navigation is in the use of check points. Many check points that were valuable in the daytime will be useless at night. And other features, not particularly prominent in the daytime, will be very noticeable at night.



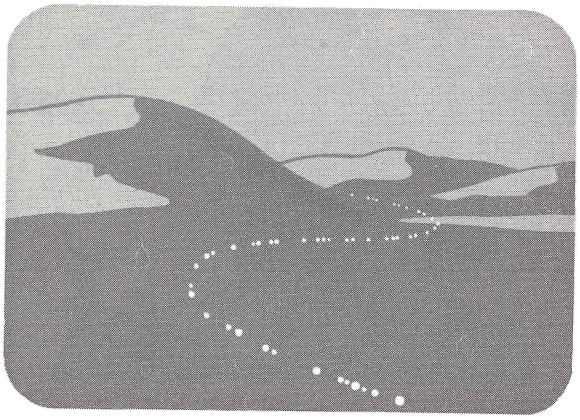
AIRPORTS (LIGHTED)



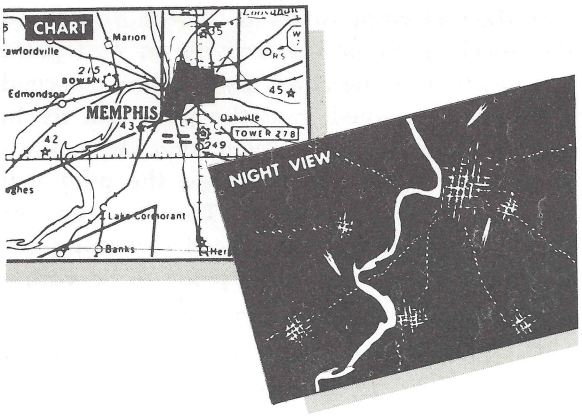
BEACONS

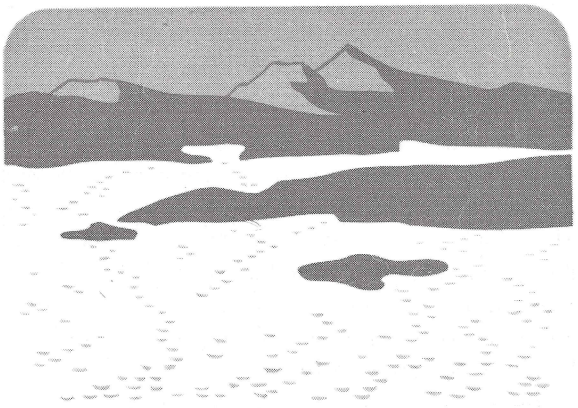


PROMINENT TOWNS AND CITIES IN OPEN REGIONS WITH A CONCENTRATION OF LIGHTS.

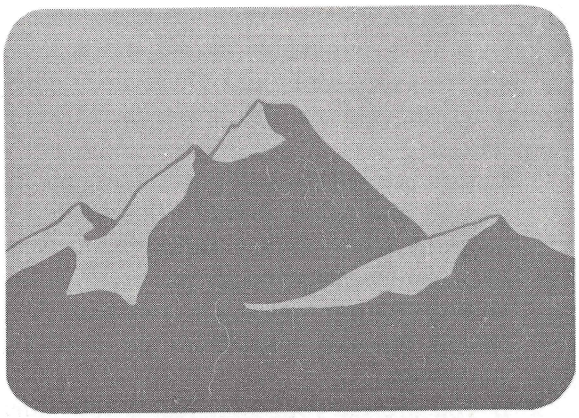


HIGHWAYS ALONG YOUR FLIGHT PATH: HEADLIGHTS OF CARS ARE EASY TO SEE.





COASTLINES, LAKES, AND RIVERS ON CLEAR NIGHTS — WATER REFLECTS LIGHT.



PROMINENT TERRAIN FEATURES; RIDGES AND MOUNTAINS SILHOUETTED AGAINST THE HORIZON.

Railroads and secondary highways usually make poor check points at night. Small towns, generally, are poor check points also because most of the lights will be turned off early in the evening. This may cause the town to appear as two or three houses. On the other hand, larger cities are very readily seen and make excellent check points. You must bear in mind, however, the fact that later in the evening some of the lights will be turned off, thereby changing the pattern of the city. Large lakes and rivers will make good check points when you are over them and able to see light reflected from them. This is particularly true on clear moonlight nights. Principal highways also provide good reference points because of the pattern formed by the automobile headlights. Late in the evening, however, the volume of traffic is likely to decrease, thus providing a poorer reference.

You will find that check points at night are usually visible for a much greater distance than they are in the daytime. For this reason it will be a natural tendency to underestimate distances at night.

Light lines on the airways provide an additional means of determining your position at night. The light lines consist of a line of individual beacons, each flashing its own particular letter in code. The beacons are approximately ten miles apart. This distance may vary, however, with terrain conditions. The pilot may be unable, therefore, to use distances between lights in making time checks. The lights are numbered in sequence along a given route. The numbers increase in the northerly direction along amber and blue airways, and in the easterly direction along green and red airways. The code arrangement follows the same sequence and runs from one to ten. The position of each beacon and its code letter are on your chart. On clear nights you can see at least two or three beacons in either direction along an airway. Most beacons flash or rotate six times a minute, and flash code letters which you can read when you are within the boundaries of the airway. Below is the corresponding

code letter for each beacon and a word beginning with that letter which will serve as an aid to memory. The words form a sentence which, when once memorized, will long be remembered. It will be worth your while to memorize this sentence:

Number	*Code Letter*	*Word*
1	W	When
2	U	Undertaking
3	V	Very
4	H	Hard
5	R	Routes
6	K	Keep
7	D	Directions
8	B	By
9	G	Good
10 or 0	M	Methods

The code letter of the beacon will also indicate the mileage to the nearest ten miles from the point of origin of the light line. Since the lights are numbered in sequence to ten, the beacon will show its location only within one hundred miles. For example, the beacon flashing the code "R" will be either fifty miles, one hundred and fifty miles, or two hundred and fifty miles from the beginning of the light line. The light lines, although they provide excellent check points, have been discontinued along some airways. You should not, therefore, count on having a light line along every airway.

With a little practice in recognizing check points at night, you will find night navigation just as easy as day navigation, if not easier.

EMERGENCY PROCEDURE

Probably the foremost thought in your mind on a navigational flight is the possibility of getting lost. This is a very real possibility if you are careless in maintaining your heading or in keeping accurate log data. Even the most conscientious and skillful pilot will, at one time or another, become temporarily confused. Whether a pilot becomes temporarily confused or thoroughly depends on whether or not he has a definite plan to follow. The greatest hazard to the pilot when he fails to arrive at a given check point at a particular time is panic. The natural reaction is to assume your position and then attempt to fly to where you think the check point is. On arriving at that point and not finding the check point there, a second position is assumed; and the pilot will fly in another direction for a given time. As a result of several of these wanderings, the pilot will have no idea where he is. The fact remains that if the pilot flys basic dead reckoning until his ETA runs out, he is going to be within a reasonable distance of his check point.

The chief cause of becoming lost is "assuming a position." If, after having flown out your ETA, your check point is not visible, it is a good idea to continue flying for an additional period of time in the event the wind has changed and decreased your ground speed. This additional amount of time will be determined by the distance from your last check point. In primary flying, the check points are so close together that five minutes will be sufficient time to fly past your ETA.

Rule number one, then, is this: If you believe you are lost, maintain your heading and fly the ETA *plus five minutes. If at the end of this time you are still uncertain of your position, you should immediately call the closest ground control or air patrol.* The instructors flying these aircraft will then give you instructions as to what to do.

In the event that you are unable to contact either the ground conrol or the air patrol or anyone else who could give you help, it will be necessary for you to use your own initiative and good judgment. Since every situation will be different, it is impossible to set down a list to apply to every situation. There are several things which you can do, however, to orient yourself:

1. Locate some prominent landmark on the ground and try to identify this landmark on your chart. Every technique learned to recognize check points can be employed to identify this unknown landmark. You should, however, read from the ground to the chart.
2. If you are on your first leg, a 180° turn will take you back into the local area with

which you are familiar and where you will undoubtedly recognize some familiar landmark.

3. Throughout the United States there are many VHF/DF (very high frequency directional finding) stations. If there are any in your locality, their use will be explained thoroughly to you during your preflight briefing.
4. Many times some prominent landmark such as a river, railroad, or principal highway will be located near your own base and near your course. If such is the case, another possibility is to fly to this river, railroad, or highway and follow it back to your home base. Such possibilities will usually be mentioned during your preflight briefing.
5. After exhausting all other possibilities, as a last resort you can drag a water tower or railroad station in an attempt to read a name of a town or city from them. This is done by flying a normal traffic pattern around the water tower or railroad station, observing carefully all obstacles such as tall buildings, trees, and wires, and then flying up-wind at a safe altitude and to one side of the tower or railroad station. This procedure should not be used at night. Remember that this is a last resort and that if it should become necessary to follow this procedure, you must report it to your instructor or flight commander immediately upon landing. If you fail to do this, you may be found guilty of violating AFR 60-16.

The important thing to remember is this: *Do not* fly aimlessly about the area, trying to find your check point. Be calm and follow whatever plan your good judgment dictates. If, after trying to identify your position by every known means, you still do not know where you are, plan to land before you run out of fuel. It is desirable, of course, to land at some landing field. If you are unable to find one, however, select a good field and fly low over it to determine whether it will be suitable for a gear-up landing. If the field is suitable, fly a normal traffic pattern and land. On the final approach, be sure to cut all switches, place the mixture in the idle cut-off position, and turn your fuel selector valve off. Remember that you should never land gear-down at any place other than a recognized airport. If the navigation flight is made at night, you should land only at a recognized lighted airport. If no airport is available, trim the aircraft in a nose-low attitude toward an unpopulated area, cut all switches, and bail out. Remember never to attempt a landing in any unlighted field at night. Even on moonlight nights, it is extremely difficult to judge height, and many pilots have been killed trying to do so.

FUEL EXHAUSTION

Unless you become lost, your aircraft is very unlikely to run out of fuel. Cruise control on the relatively short flights you will be making will give you a large safety margin of extra fuel. But in the event you should run low on fuel, follow the same procedure as outlined in lost procedure. This is the important thing: land before you run out of fuel.

RADIO PROCEDURE

At each of the turning points of the navigation flight there will be a ground-control supervisor. As you pass over this turning point, you should call in and give the number of your aircraft and any additional information that may be requested at your flying school. Be sure your call is acknowledged. The reason for calling is that if you should become lost the search planes would know a little more definitely where to look for you. If your call is not acknowledged, it may be that it never was received. On night navigation flights you should flash your landing light as you make the radio call. This is to enable the ground-control officer to identify your position.

After completing the navigation flight and landing at your home base, be sure that you call the tower and report that you have returned. If you fail to do this, a search will be started shortly thereafter. This would prove

embarrassing for you, not to mention the inconvenience of others involved.

All other radio transmission should be held to a minimum. If you are blocking the frequency with needless calls, you may prevent someone from calling in the event of an emergency. Strict radio discipline must be observed.

RADIO FAILURE

You should never start out on a navigational flight unless your radio equipment is operating properly. If it should fail during the first part of the flight, the best procedure is to make a 180° turn and return to your home base. If you have progressed to a point where it would be just as far back as it would be to continue on the flight, then you might as well continue. At each turning point, however, be sure to drag the field so that the ground control officer can identify your number. Dragging is done by flying a normal traffic pattern around the field and an approach to the runway no lower than two hundred feet. Remember that two hundred feet is the minimum altitude for dragging the field. If the turning point is not at an airfield, then, of course, do not drag a city, but continue on course. In any event, report the radio failure to your instructor immediately upon returning to the home base.

FORCED LANDINGS

Of course you will be subject to forced landings on a navigation flight, just as you are on a local flight. Just remember to use the same techniques that you learned during contact flying and keep looking for suitable fields. At night the only procedure is to bail out. Exceptions to this rule occur, of course, when you are certain you can make a landing at a lighted field or when you are too low to bail out, as during take off or landing.