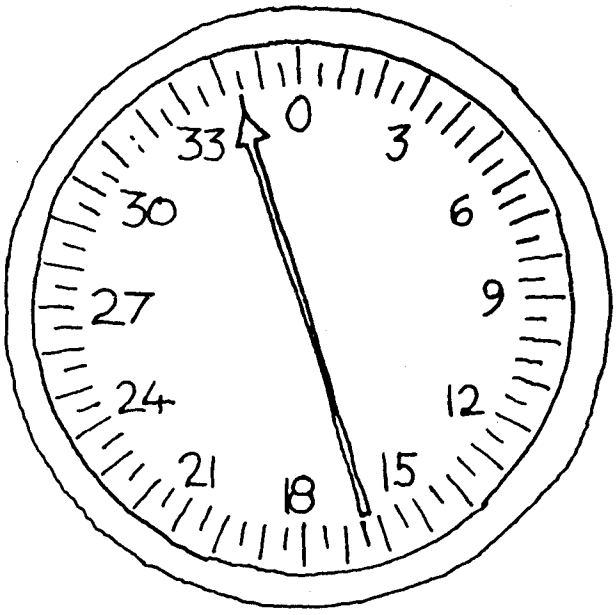
AN APPROACH TO ADF

This step-by-step handbook will show you how to make instrument approaches with an "archaic" navaid that is cheap to install and widely available, but little used.

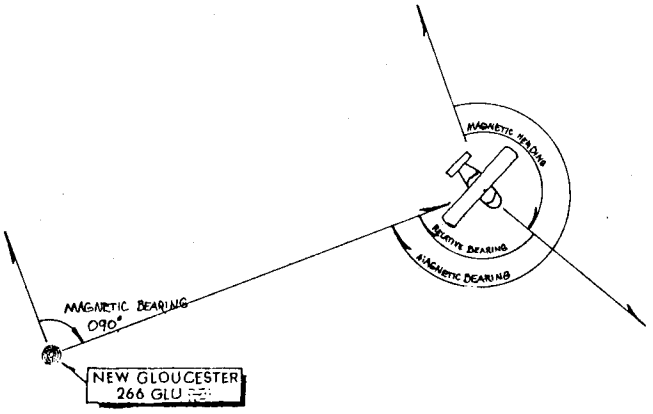
Written (literally) by Otis Hardy Maclay



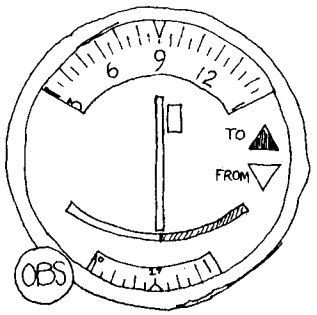
For a while it has seemed as though ADF was phasing out. The FAA was decommissioning ILS outer compass locators, and most airports would beg and plead for VOR approaches if they didn't have an ILS. But recently there has been a trend among airport operators to install Non Directional Beacons for instrument approaches, and, in fact, there are more NDB's being commissioned these days than any other kind of navaid. The reason is fairly simple: beacons are cheap and simple to install. The only disadvantage for instrument pilots is that not all of our training included enough ADF time for proficiency. Even

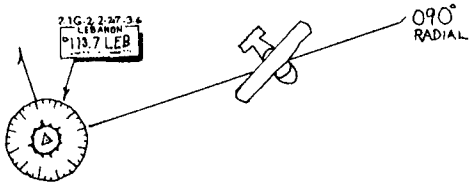
when we understand the theory, the practice can often become sticky and confusing.
What we have done here is to show the pertinent instruments at every stage of an ADF approach right up to the landing in hopes that some of the confusing events that accompany an ADF approach will begin to make sense. Of course, nothing will replace practice, but a clearer understanding of what to expect can make the work easier and more predictable.
We also have a quick review of the fundamental principles for those of us who have ignored the ADF long enough to have forgotten where the on-off switch is.

Magnetic Heading is the angle between Magnetic North and the nose of the plane.
Relative Bearing is the angle between the nose of the plane and the station.
Magnetic Bearing is the angle between Magnetic North and the station.
The formula is: MAGNETIC HEADING + RELATIVE BEARING = MAGNETIC BEARING.

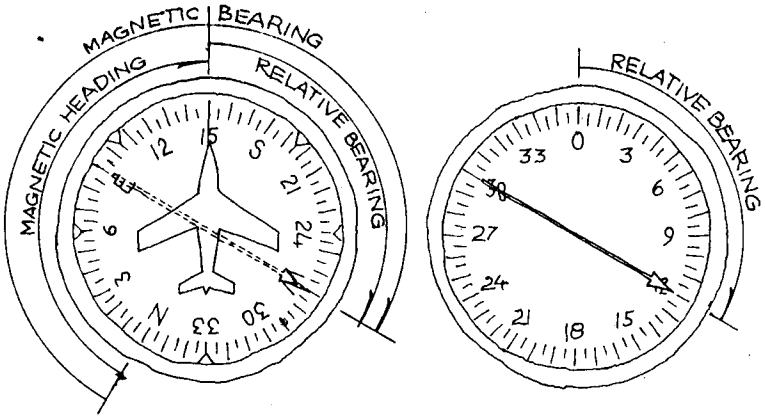


When you're on the selected radial, the needle centers no matter what the heading. In other words, the VOR does the work for you. With the ADF you have to figure things out for yourself.

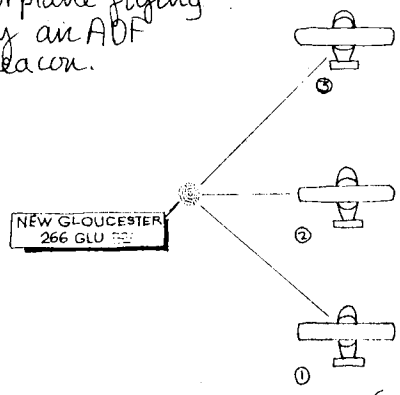


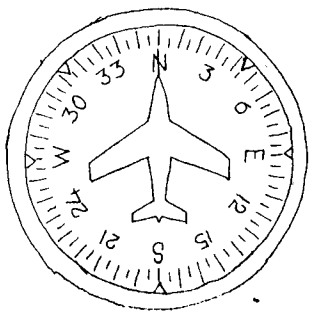


A simple way to figure your magnetic bearing is to count around on the D.G. the same angle shown on the ADF dial. In the example, the ADF shows 120°, so you count 120° around on the D.G. (You can make use of the 45° and 90° markers to help.
Essentially, you are transposing the needle from the ADF to the D.G.

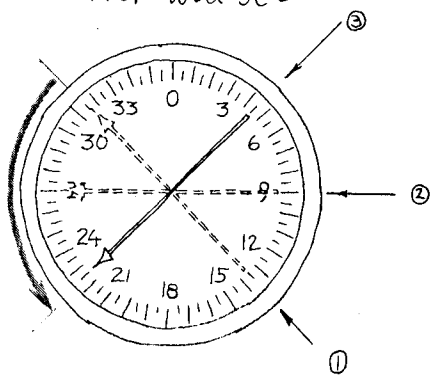


Imagine an airplane flying by an ADF beacon.





The indication on the ADF will be so:



So we can say that, unless we're tracking directly to or from the station, the head of the needle falls and the tail rises. Our strategy in all our maneuvering is based on this fact. In other words what we try to do is set up a situation where the needle will fall where we want it, and then fly a heading which will hold the needle steady.

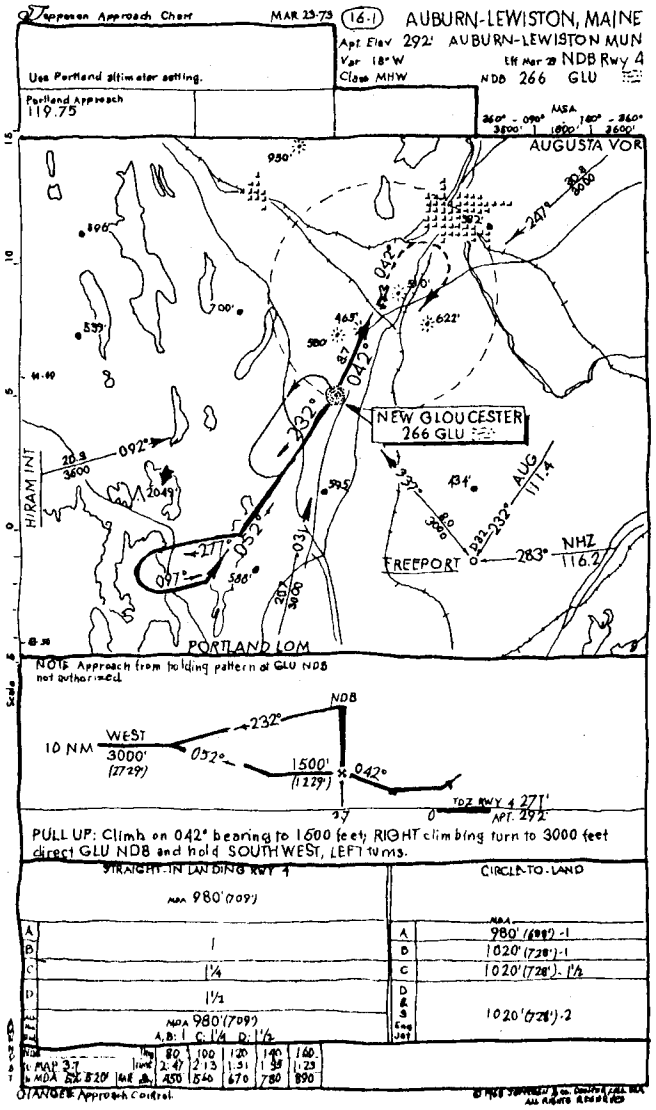
The discipline imposed on us by an ADF approach is the same as in a VOR approach — i.e., we have to make good a track with reference to the station. (The track is our path over the ground.) In a VOR approach, this is relatively easy since the needle is centered when we're on track no matter what the heading.

The difficulty of the ADF approach is that everything moves whenever we change the heading. At first it seems outrageous and hopeless, but it isn't.

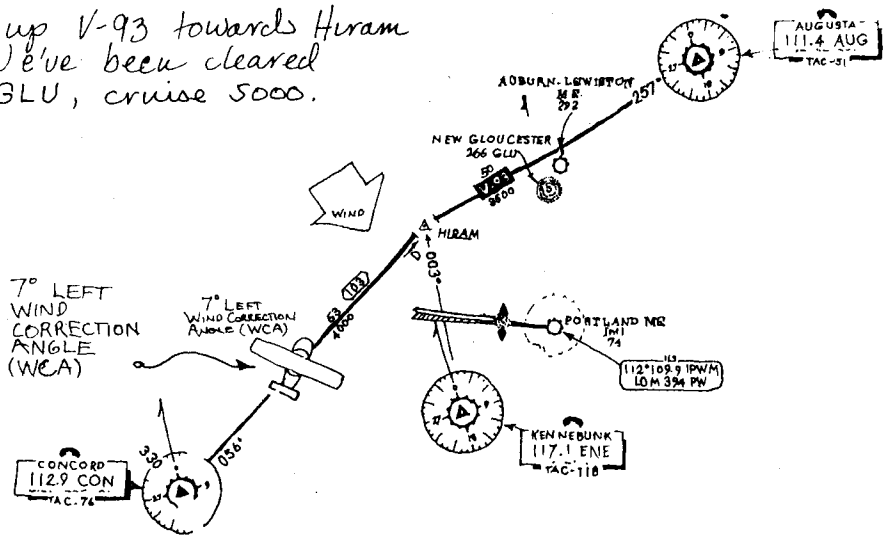
Good thoughts and right living will see us through.

We'll do the approach to Auburn-Lewiston Municipal which is interesting and typical. And besides, Bowdoin College has a good basketball team in case the weather goes down and we can't get out.

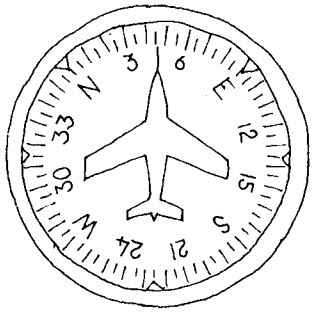
It's an interesting approach because there is a heading change — from 052° to 042° at the beacon.

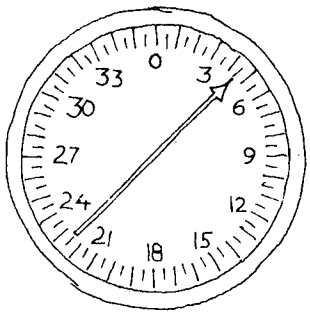


We're flying up V-93 towards Hiram intersection. We've been cleared Hiram direct GLU, cruise 5000.

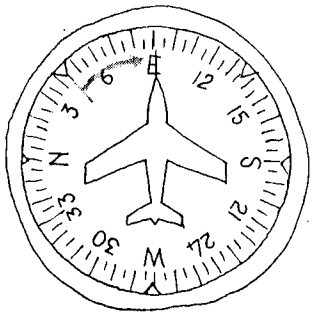


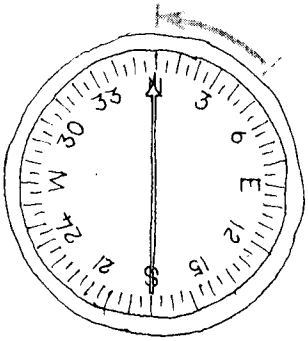
At Hiram, the DG and ADF dials look like this.

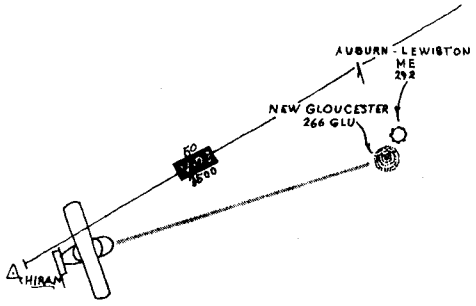




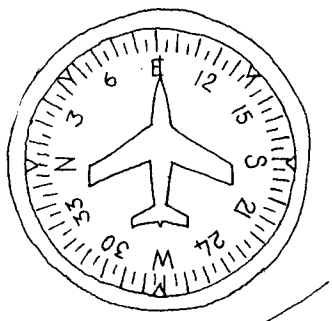
We turn to a heading of 092° (which puts the head of the needle directly ahead) to follow the terminal route shown on the approach plate and start a descent to cross the beacon at 3500'.

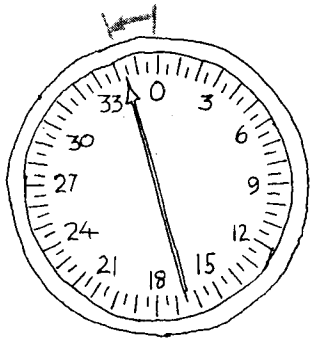


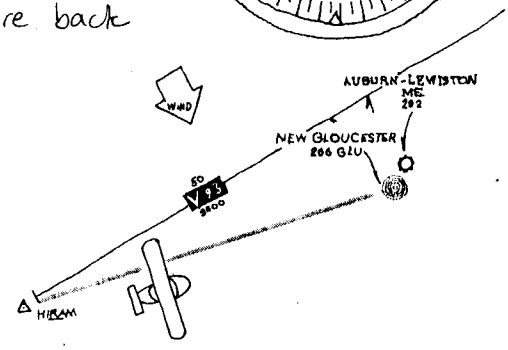




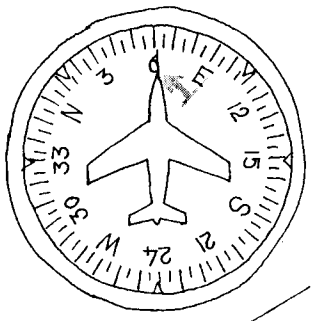
Since we have a wind from the
t, we are moved off our track
092° to the beacon. The needle
ves toward the wind (everything
say about the needle moving assumes
keep our heading constant). We have
correct our heading, but how big
correction should we make, and
w will we know when we're back
track?

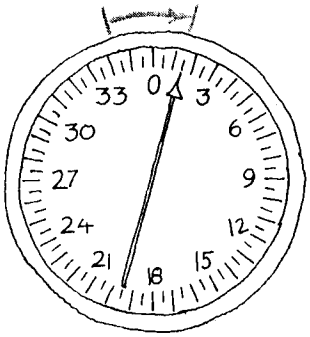


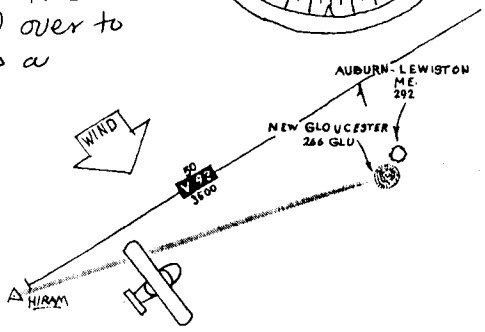




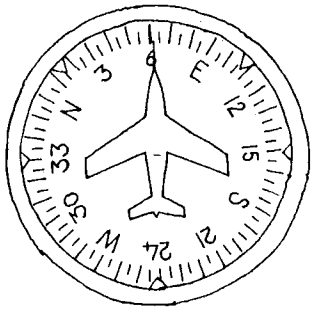
The rule of thumb is to make a
ding correction twice the size of the
ift error. In this case we have
ifted 15° to the right, so we turn
ice that towards the left. We hold
heading and wait for the needle
move the same number of degrees
s off now. Notice also that the
ad of the needle has crossed over to
e other side of the zero as a
sult of our heading change.

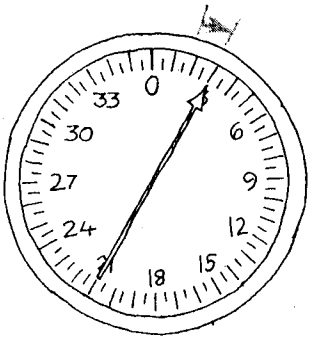


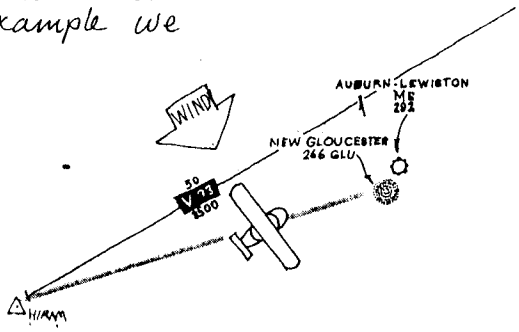




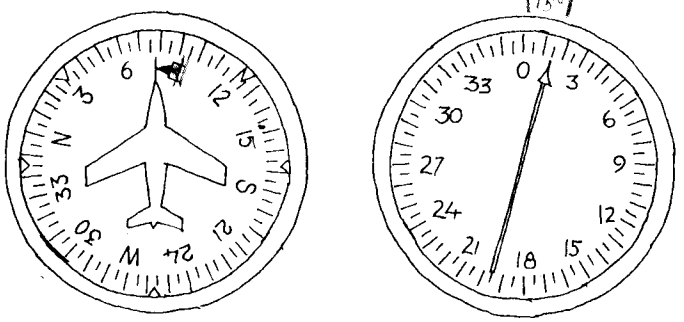
After the needle falls another 15°
are back on track. In all inter-
ptions, we are on track when the
DF needle shows the same deflection
s our intercept angle. The needle
showing 30°, so we are back on
r track. Since we drifted in the
irst place, we know we need a wind
rrection, so we turn back to
r heading minus a Wind Correction
ngle (WCA). In the example we
ve chosen 15°.



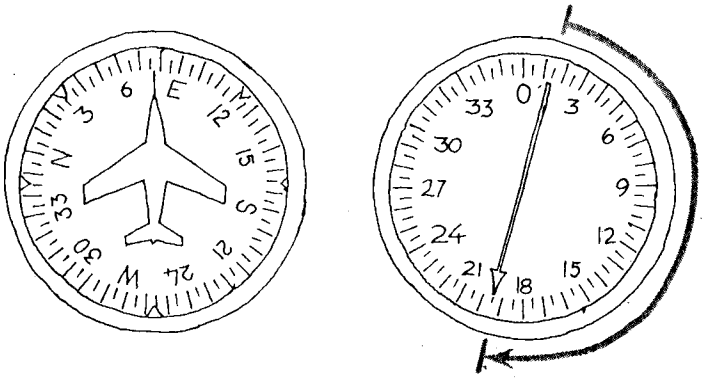




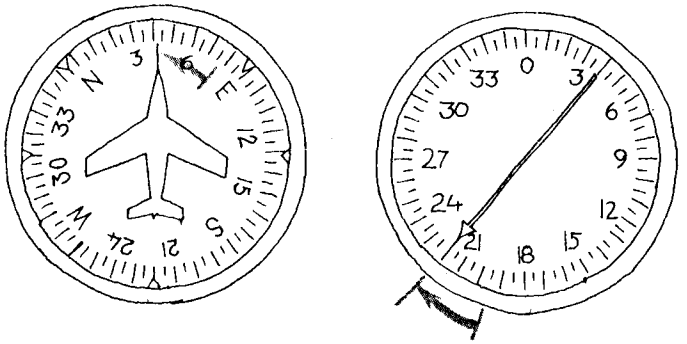
After we make the heading correction, we see this. As we get closer to the beacon, the needle will become increasingly sensitive. It becomes increasingly important to hold the heading absolutely accurate – which means wings absolutely level.



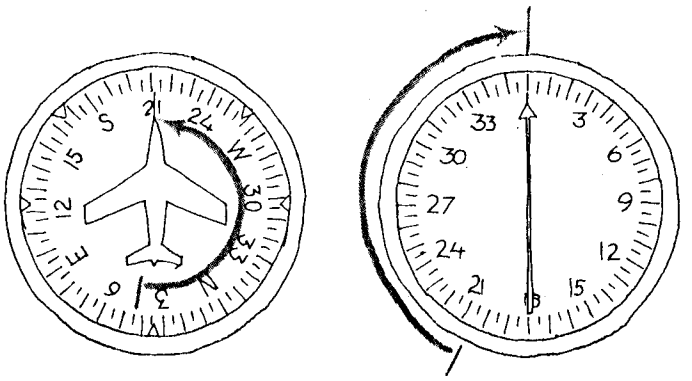
As we cross the beacon, the needle will swing to point aft. Notice the tail of the needle now points to where the head did before.

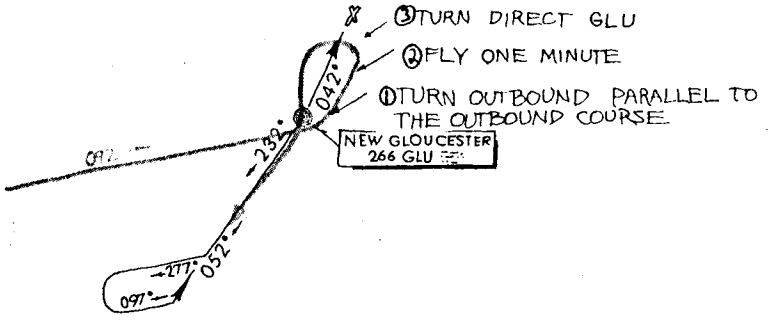


As soon as the needle swings around, we turn to parallel the 042° inbound heading. We fly for one minute to give ourselves time to get set up ....

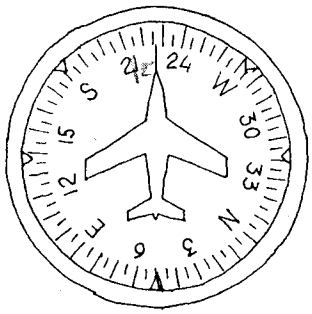


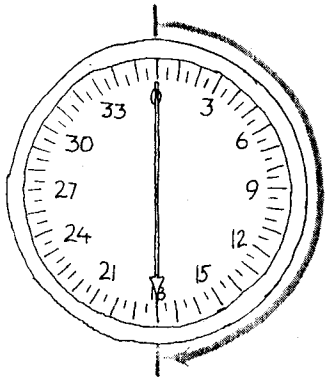
then turn the shortest distance (left) direct the beacon.





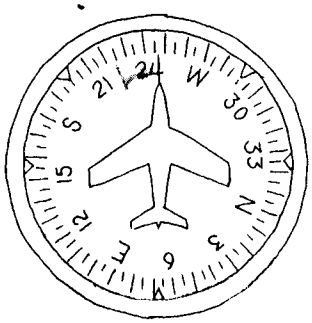
As soon as we cross the beacon, we turn to intercept the outbound course. Since we are only 5° away from it we have to watch the needle most closely as the change will be small.

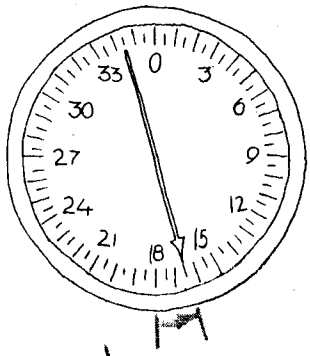




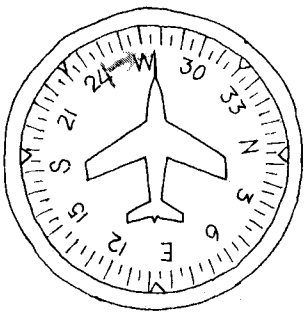
When the needle shows we're on track we turn to the heading that will make it good. We've been allowing 15° for the wind so we'll continue to do so.

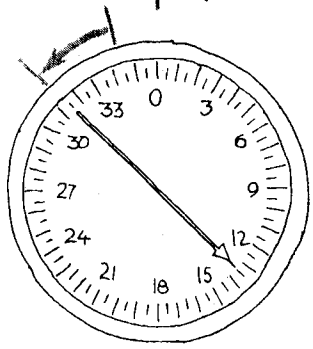
We fly outbound for one minute (or two if we want a little more time). Our only limit is the distance from the fix depicted on the approach plate.



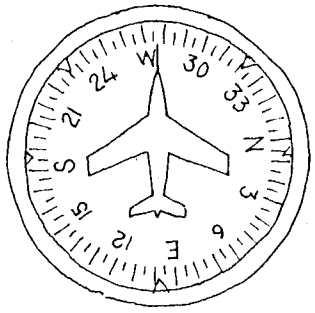


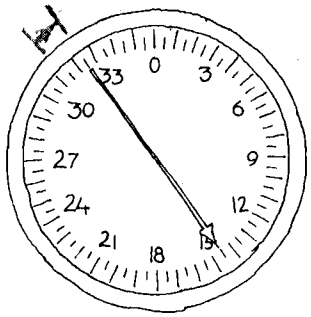
After we've flown outbound for one minute (or two) we can start the procedure turn. The easiest thing is to simply turn to the depicted heading (277°).

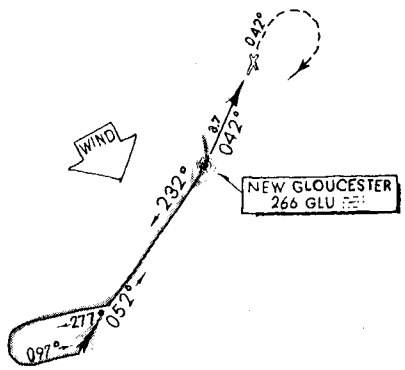


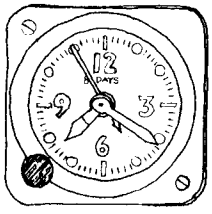


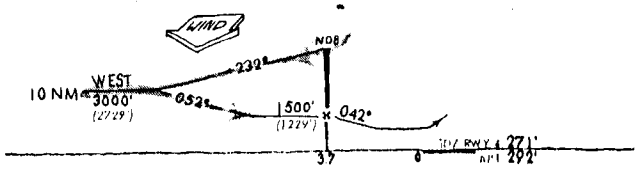
As we fly the needle moves as indicated.



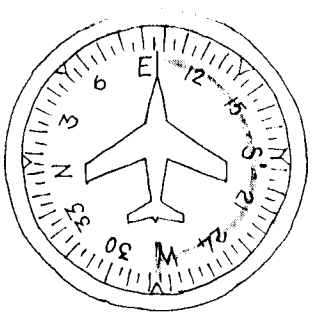


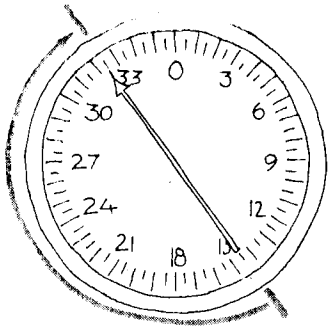


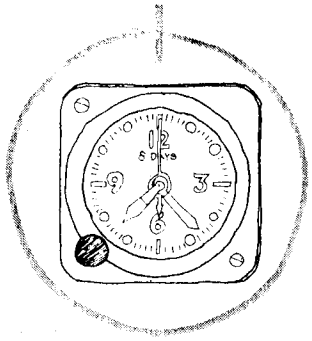


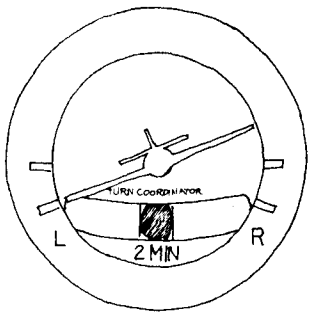


After a minute on the 277° heading, we do a left 180 to the reciprocal (097°). Notice that what we have set up is a 45° intercept to the inbound track.



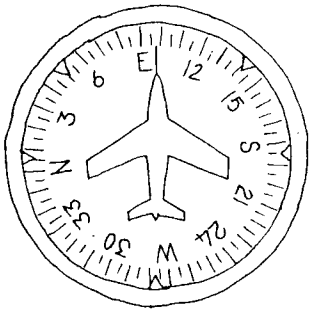


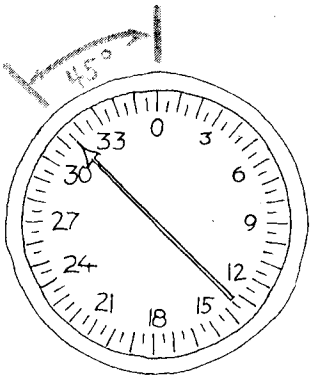


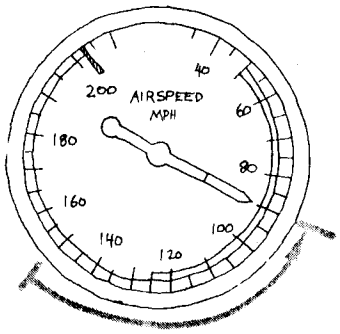


STANDARD RATE TURNS ALWAYS

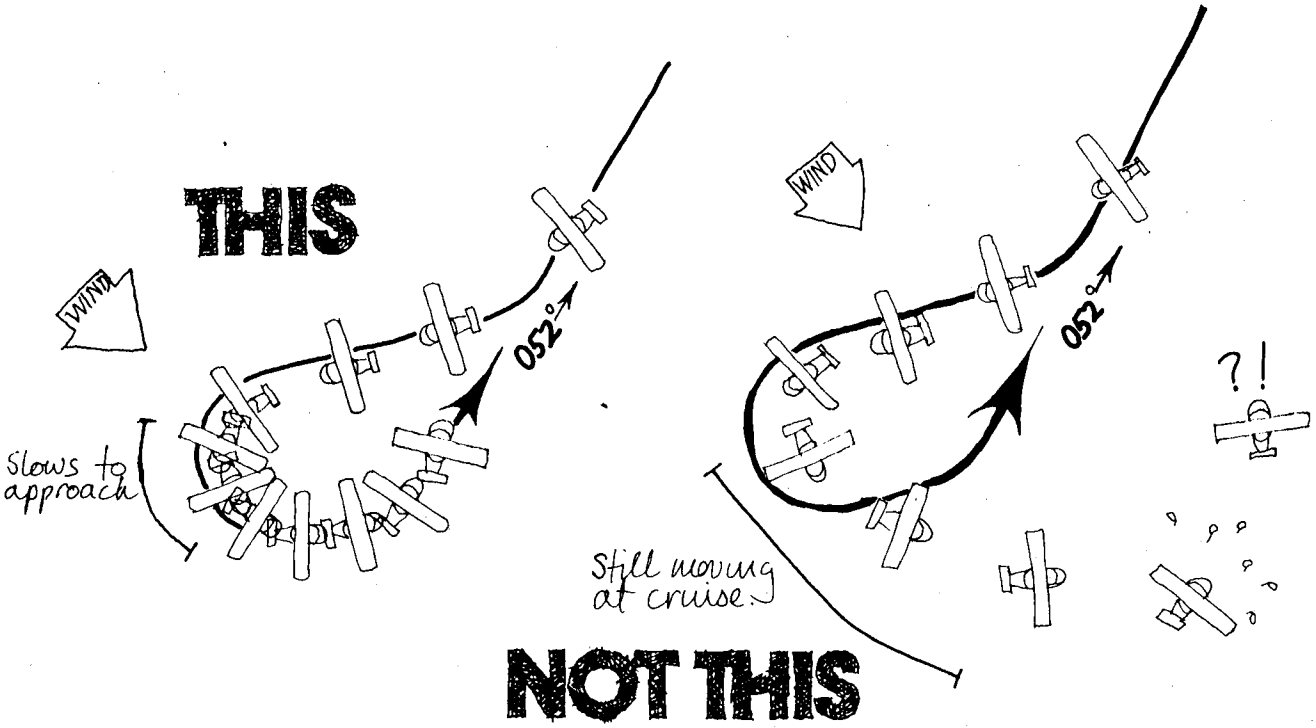
When the needle reaches a deflection equal to the intercept angle (45°), we are on track, and we can turn inbound.

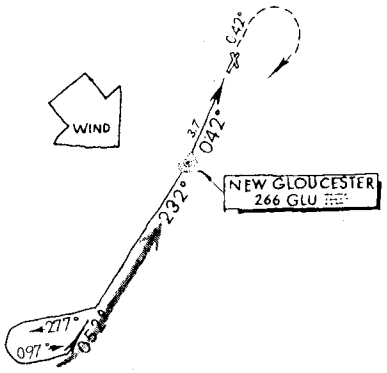


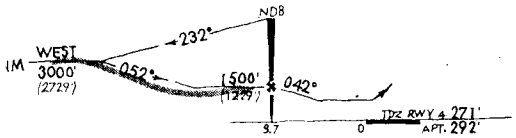




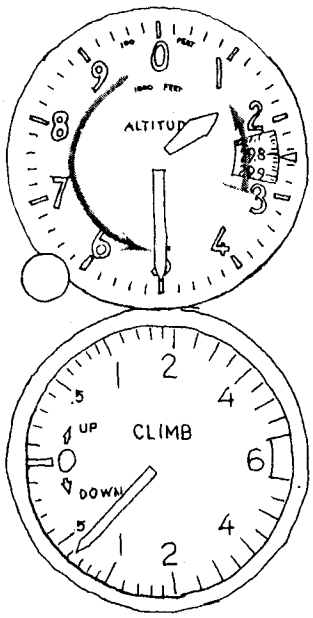
As we do the 180° turn, we slow to approach speed to fool the wind and keep ourselves from being blown across the inbound track.





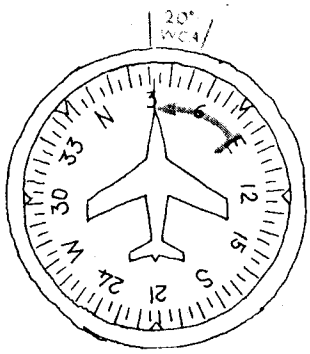


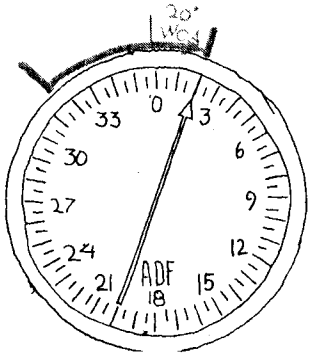
Once we're inbound, we bring the throttle back to start a descent. We want to cross the beacon at 1500'.



Because we slowed down in the procedure turn we need a bigger WCA to stay on track. We'll add 5° (a nice round number) to the 15° we've been using.

An easy way to turn to the new heading is to put the needle under the new WCA. We hold our heading, changing it only to make corrections if we drift off track.

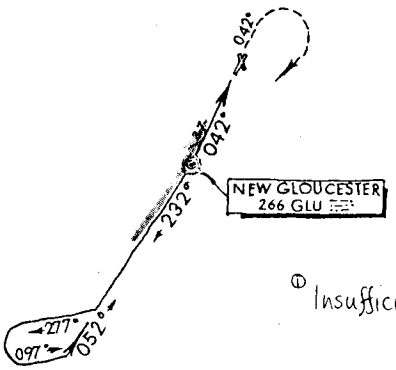


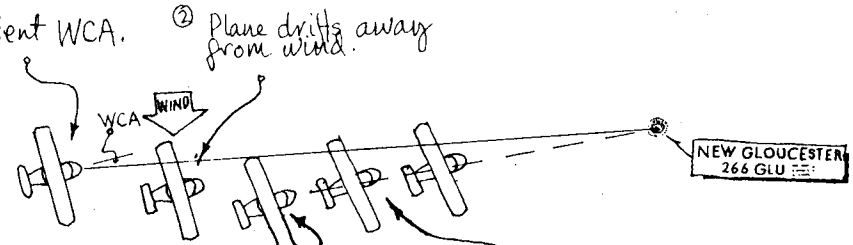


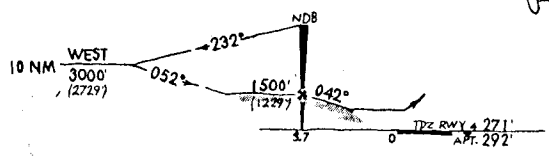
As we fly inbound, we want to stay right on track. Since it's unlikely our WCA is exactly right, we're going to have to make corrections. If our corrections are too big, we'll get lost.

If they're too small, we'll end up following another track.

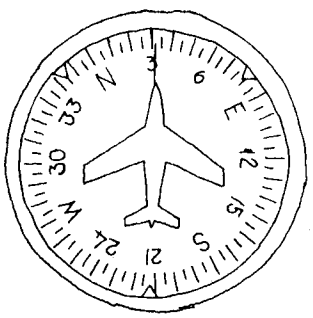
Our corrections have to be just right.

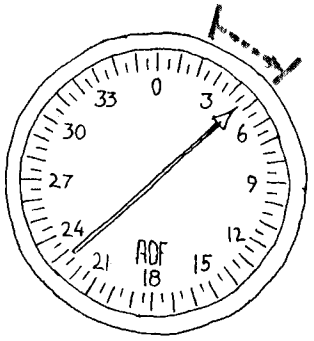




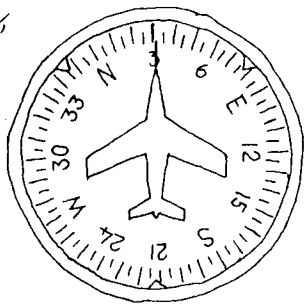


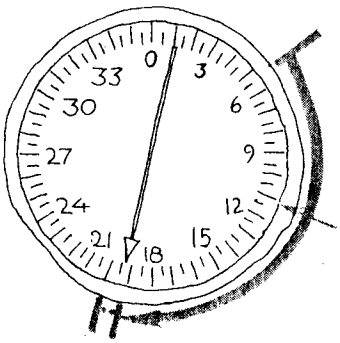
As we get near the beacon the needle becomes increasingly sensitive. Presumably we're pretty well established on the track, so the best thing for us to do is hold our heading and ignore the needle until we cross the station.





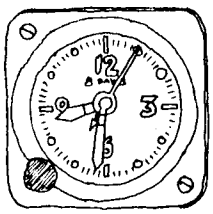
When we finally cross the beacon, the needle will fall to the tail. As it passes abeam, we spring into action.



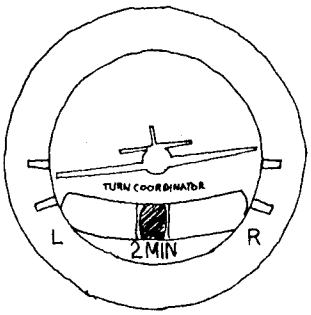


THE FOUR "T"s:

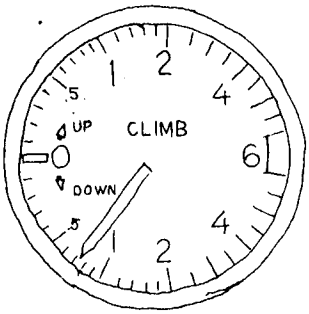
CROSSING THE BEACON



TIME
(Note the time.)



TURN
(to the inbound heading)



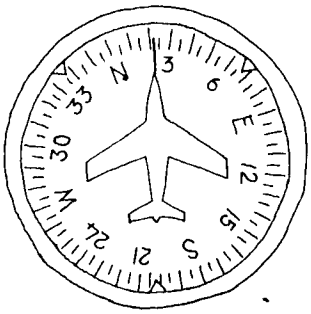
THROTTLE
(back, to descend to the MDA.)

US: "PORTLAND APPROACH, 34 YANKEE, BEACON INBOUND AT 32."
HIM: "ROGER, 34 YANKEE, REPORT FIELD IN SIGHT."
US: "34 YANKEE."

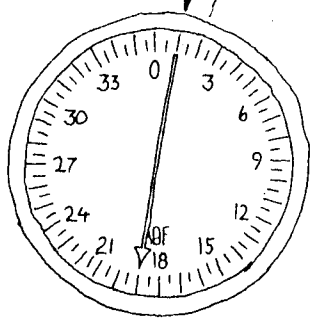
TALK
(As soon as everything is under control.)

BUT...

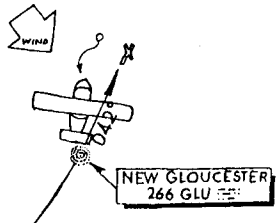
Murphy's law tells us, "If something can go wrong, it will," so when we turn, either we get this ....



TAIL LEFT OF WHERE IT SHOULD BE...

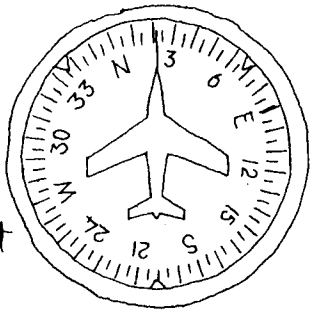


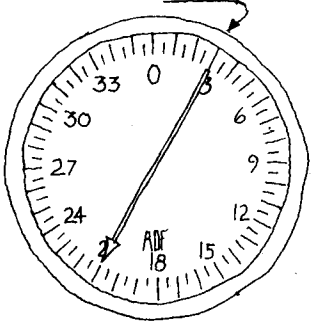
LEFT OF TRACK



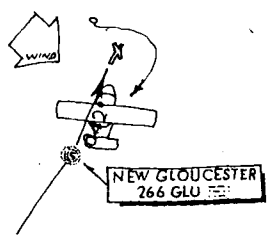
RIGHT OF WHERE IT SHOULD BE...

... or this. To beat Murphy, we are careful to be at the exact heading — 042° minus the 20° left WCA — so we can tell by the ADF needle's tail what correction to make.

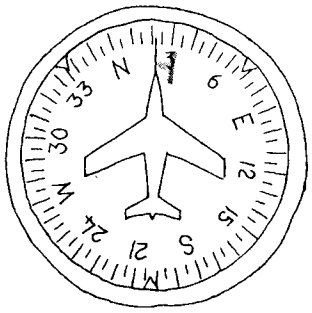


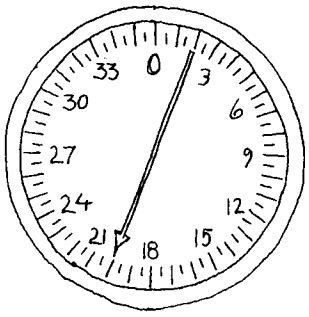


RIGHT OF TRACK

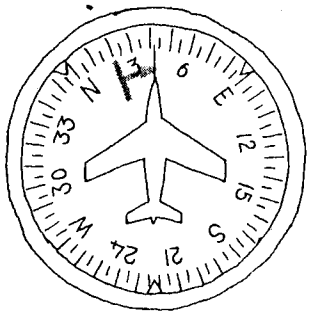


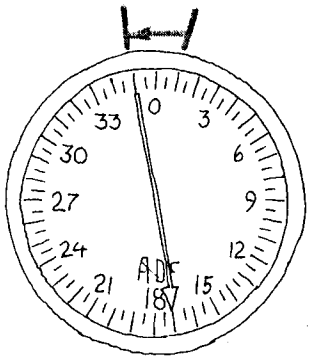
If we turn to the new heading as soon as we cross the beacon, i.e. when the needle points 90° off the track, we may be able to track straight outbound on the 042° bearing without having to intercept. The heading change is only 10° so our WCA should be about the same if not exactly.



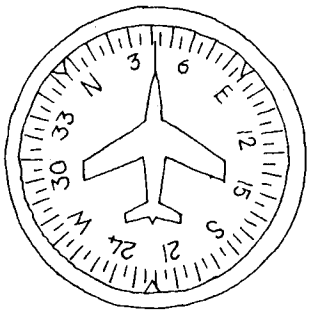


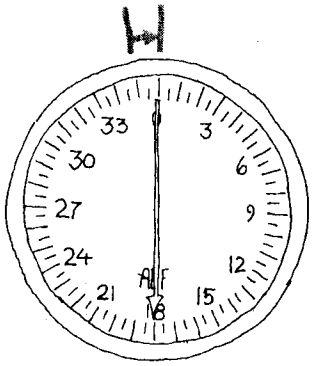
Say the tail is left of where it should be. We turn right — away from the tail. The fact is that 20° is a relatively large correction when we're inbound to the airport from the station. This is because there was a heading change at the station, and we were quite a ways off our track. (10° is a lot when we're station inbound.) In general, we limit our heading changes to 5° or so. This is why we try to get the heading and track pinned down from the procedure turn inbound to the station.



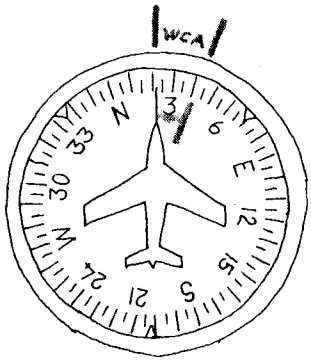


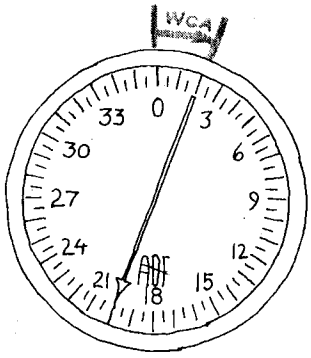
The tail will rise rapidly because we are close to the station and because our heading correction is fairly large.





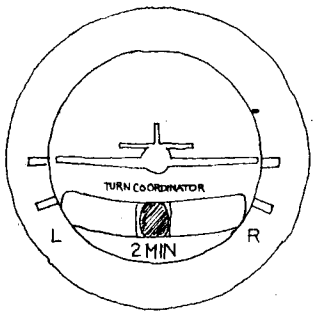
We'll assume that the WCA we've been using is good and that it was the turn to the new heading that got us off our track. As we do all the other business of the approach, we shall have to keep our eyes on the needle, and very carefully keep the wings level so our heading change. We mustn't forget that the ADF's track information is relative to our heading and must be compared with it. The needle moves when we turn as well as when we move off our track. The best way to stay accurate is to maintain our heading so that any movement

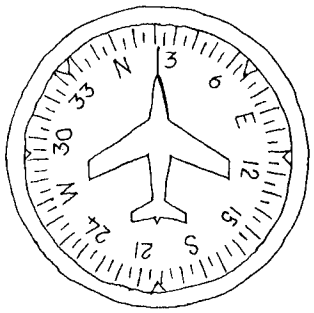




of the needle is a result of deviation from our track. Should we see the needle move, we must be sure our heading is correct before we can take any action. In addition, we must be sure we aren't turning unconsciously as the needle drifts off the track in an effort to keep it in the same place.

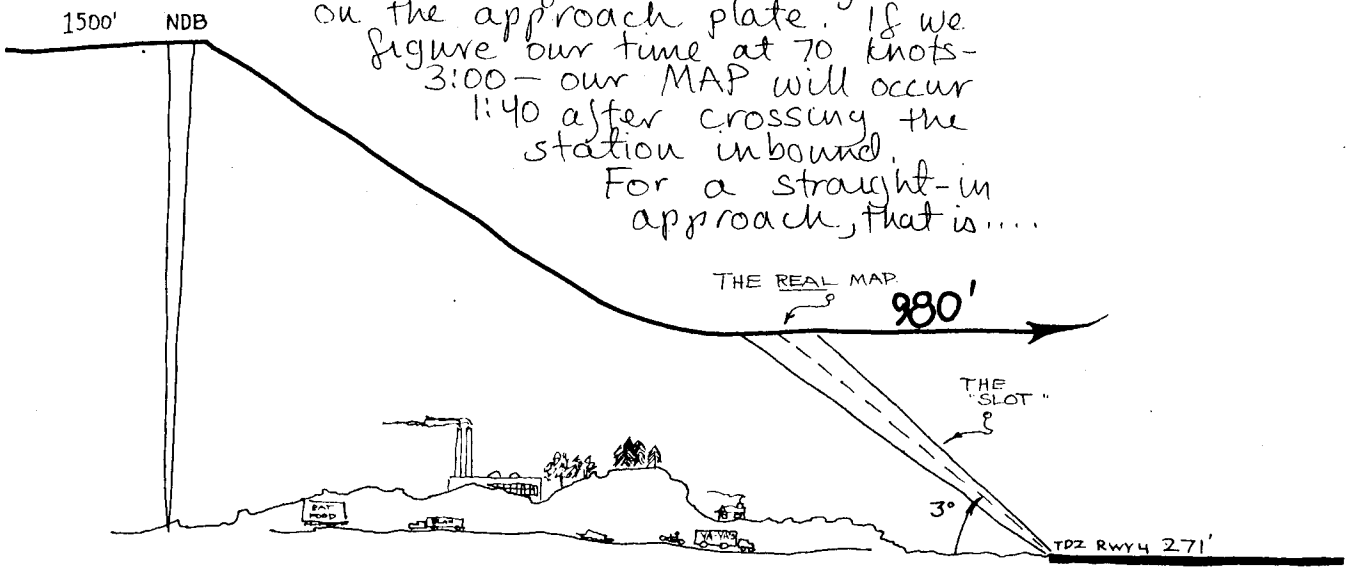
We must keep our heading constant. That's all.





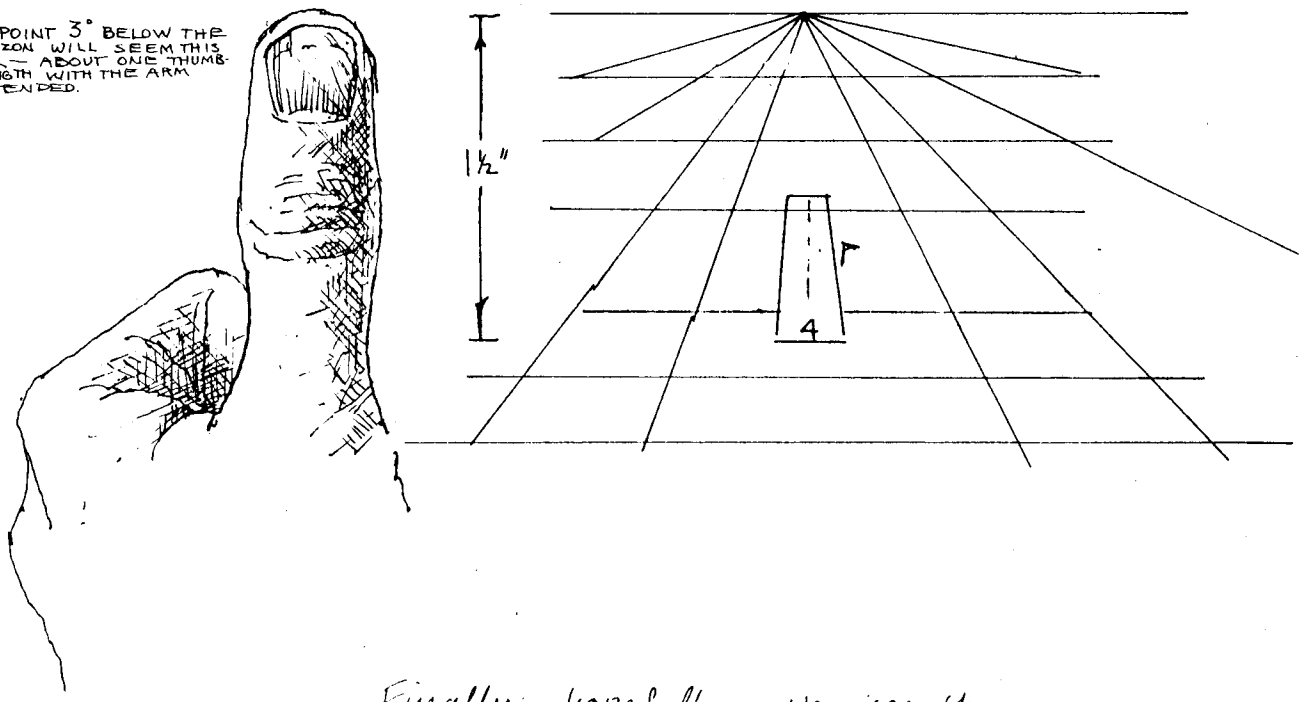
Our approach speed is 90 miles an hour—about 80 knots—minus the headwind component—say 10 knots. Our descent rate will be 450-500 feet per minute—and it will take us about 1 minute 20 seconds to descend the 700 feet to the runway from the MDA. That means our MAP will occur 1:20 before the time given on the approach plate. If we figure our time at 70 knots—3:00—our MAP will occur 1:40 after crossing the station inbound.

For a straight-in approach, that is....



WE WANT A 3° APPROACH ANGLE— STEEP ENOUGH TO CLEAR GROUND OBSTRUCTIONS; NOT TOO STEEP TO DEVELOP HIGH SINK RATES. WE CALL THIS APPROACH PATH "THE SLOT."

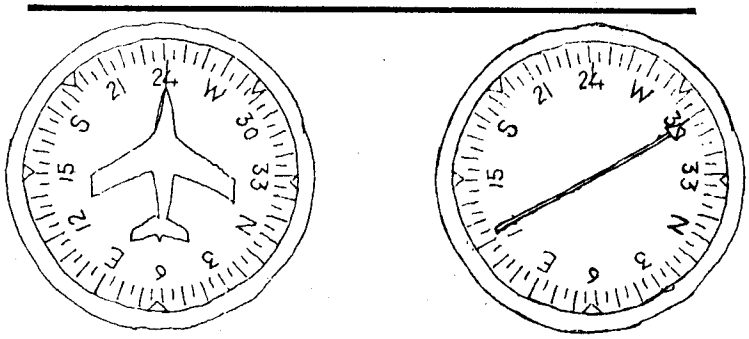
If we accept a circling approach we can continue the full time. Since the MDA in this particular approach is the same whether we're circling or landing straight in, we might as well continue. But past the slot, we will not attempt to make the runway without circling.



Finally, hopefully, we see the runway clearly and land only to discover after all that work that the airport restaurant has closed, and besides, the weather is clearing up so our friends will not be impressed at our great skill and daring.

We know, however, that the study and practice was worth it because we are able to pick an airport for its convenience and not for its approach aid. Furthermore, we have a solid backup in case our VOR goes poo — not just a nodding acquaintance with the mysteries of the ADF.

We are pilots — skilled and able — and very good looking as well.



By the way, many ADF's have rotatable cards, so all you have to do to get your magnetic bearing to the station is set your heading on the ADF with the HDG knob. Here the relative bearing is 60° — and the rotatable card tells us without figuring that the magnetic bearing is 302°. Isn't that neat?