FLYING THE "d VALUE" IN AUSTRALIA

by A.F. Woolcock

The "d value", or "delta value", (Stidd, 1948) is the name given to the difference between the "absolute altitude" (height above M.S.L.) of an aircraft, and the "pressure altitude", as shown by the aneroid altimeter. The term is also somewhat loosely used in aviation circles to indicate the difference between the readings of the radar altimeter (height above terrain) and the aneroid altimeter. The two "d values" would be the same only when the aircraft is flying above an ocean surface and, for at least the first part of this article, this will be assumed to be the case.

The use of this figure is an important part of the technique of "pressure pattern" and "single heading" flights (Sawyer, 1948), and is also of value to the meteorologist, mainly in the preparation of upper charts (e.g., Lillywhite 1951). These applications of the "d value" are made widely overseas and to a limited extent in Australia, and, as more Australian aircraft are fitted with radar altimeters we will find them extending here.

But, given the installation of these radar altimeters the "d value" can be used in the navigation of aircraft using normal procedures, provided certain basic principles are understood.

No claim is made that the material here presented is new; the relevant arguments have been propounded, and the formulae derived, long since (see refs.), but rather an attempt is made to illustrate this fact, and to demonstrate some of the possible uses of the "d value" by reference to the charts normally used in a weather office.

Implications of the "d value".

The fact that a difference between pressure altitude and absolute altitude exists is merely a demonstration of the fact that the aircraft is flying in an atmosphere which possesses properties different from those of the "standard" atmosphere used in calibrating the pressure altimeter. This standard atmosphere (either I.C.A.N. or I.C.A.O.), assumes still air. Far greater implications, however, can be drawn from the observation of this difference, and from noting the changes in it.

Consider an aircraft flying at a pressure altitude of, say, 10000 feet on the I.C.A.N. scale - i.e., following normal Australian procedure, with the altimeter adjusted to a M.S.L. pressure of 1013.2 mbs., and a "flight plan" altitude of 10000 feet. The aircraft will then be moving through the air along a constant pressure surface of 697 mbs. (= 10000 feet in I.C.A.N. atmosphere), and varying its actual altitude as this pressure surface rises or falls.

During the flight represented by the cross-section in Figure 1, over the region A - A_1, since the constant pressure surface rises, then the height interval of the layer M.S.L. - 697 mbs. has increased. Examining also the changes shown by the altimeters over this region, we see that the difference absolute altitude - pressure altitude has increased and has always been positive. Connecting the change in contour pattern with the change in "d value" along the route (Figure 2), we see that

(i) If the "d value" does not vary, the flight is being made in the direction of a contour line, and there is no cross-track component of the (geostrophic) wind - i.e., either direct head or tail wind, or no wind.

(ii) If the "d value" is changing, and becoming greater (positive change), then there is a cross track component of the (geostrophic) wind which will tend to deflect the aircraft to the right - i.e., the aircraft has starboard drift.

(iii) If the "d value" is changing, and becoming less (negative change), then the aircraft has port drift,

It has also been shown (R.A.F. 1946) that, making the usual assumptions, and using the geostrophic wind equation, formulae may be derived by which the magnitude of these cross-track components may be assessed.

Using the formula (R.A.F. 1946)

$$V_n = \frac{21.47\ (d_2 - d_1)}{S \sin \phi}$$

where

V_n = wind component normal to the aircraft heading in knots (cross-track component).

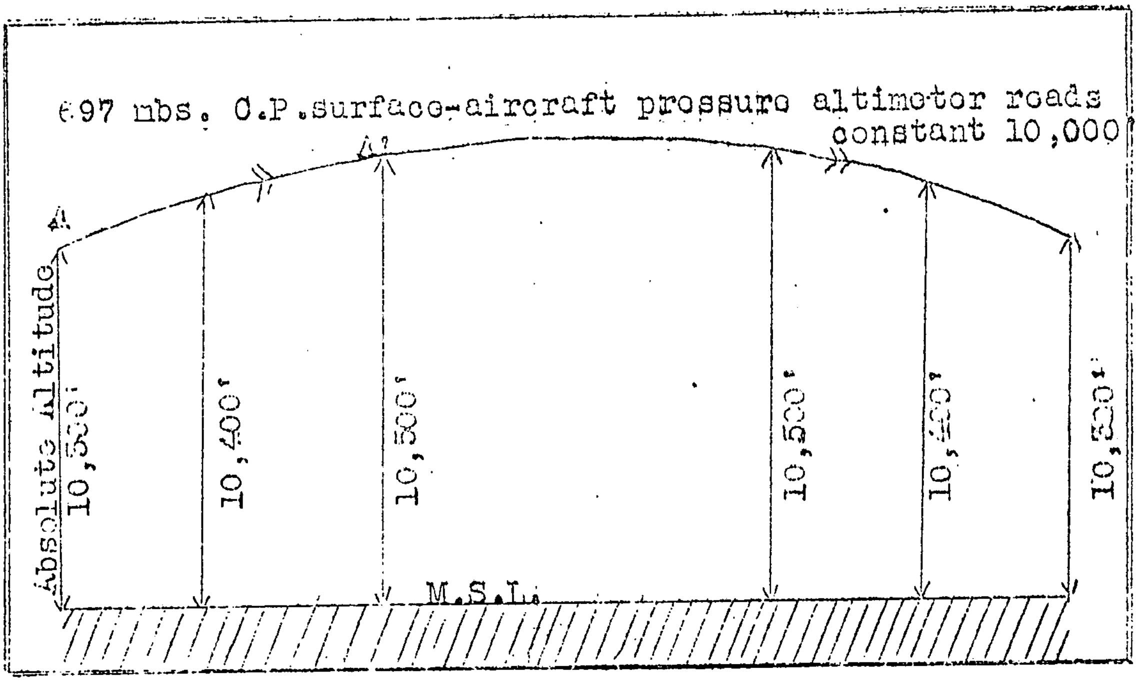

Figure 1.

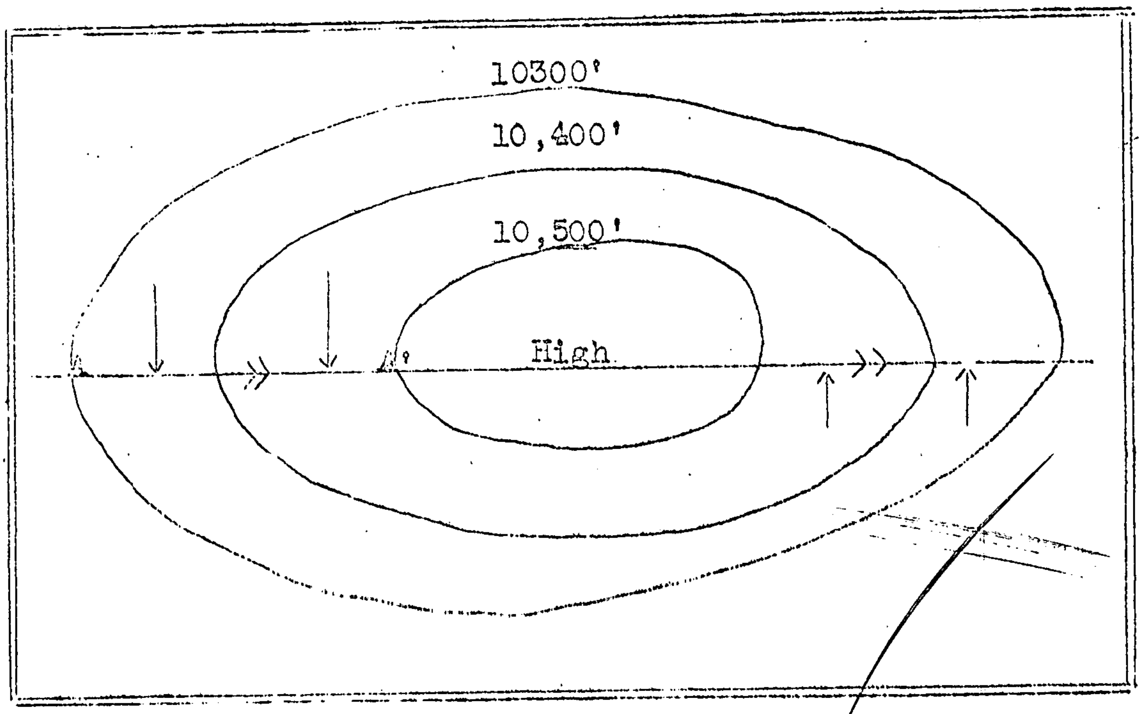

Figure 2.
C.P.Chart of 697 mbs. Surface.

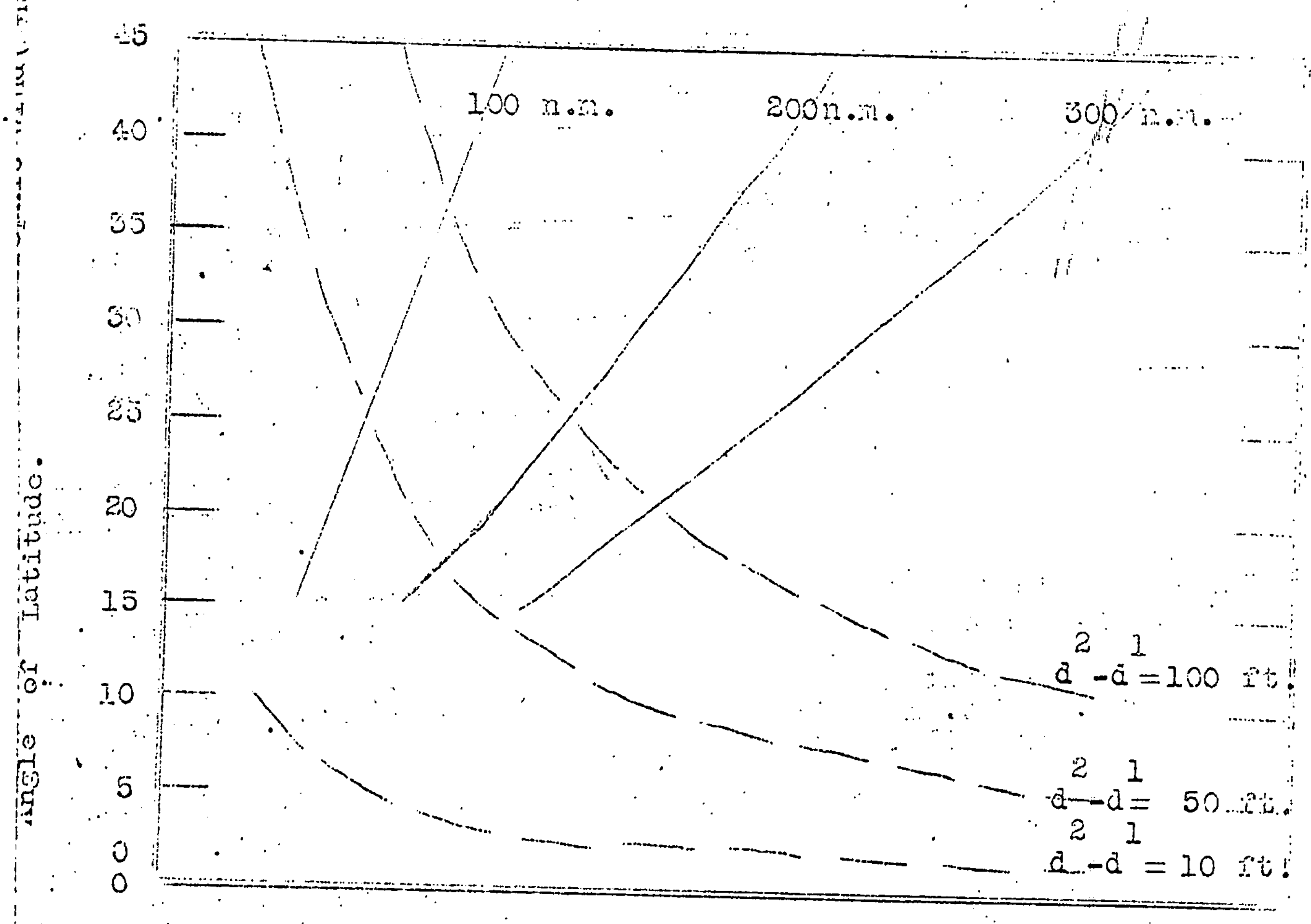

Figure 3.

Explanation of Figure 3

1) The graph is meant to be used with "d" value differences taken at hourly intervals.

2) Solid lines represent "distance travelled" in this time (from air speed).

3) Dashed lines are lines of "d" value difference.

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(a Select appropriate latitude on left-hand scale.

(b) Follow to intersection with relevant "distance travelled" line.

(c) Move up or down from this line to line showing change in "d" value.

(d) Then, value on L.H. scale opposite this point is cross wind component in knots - to port if change in "d" value negative, to starboard if positive.