~~CONFIDENTIAL~~

Why Chaff

REVISED FOR MEDIUM BOMBERS

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ILLUSTRATIONS BY
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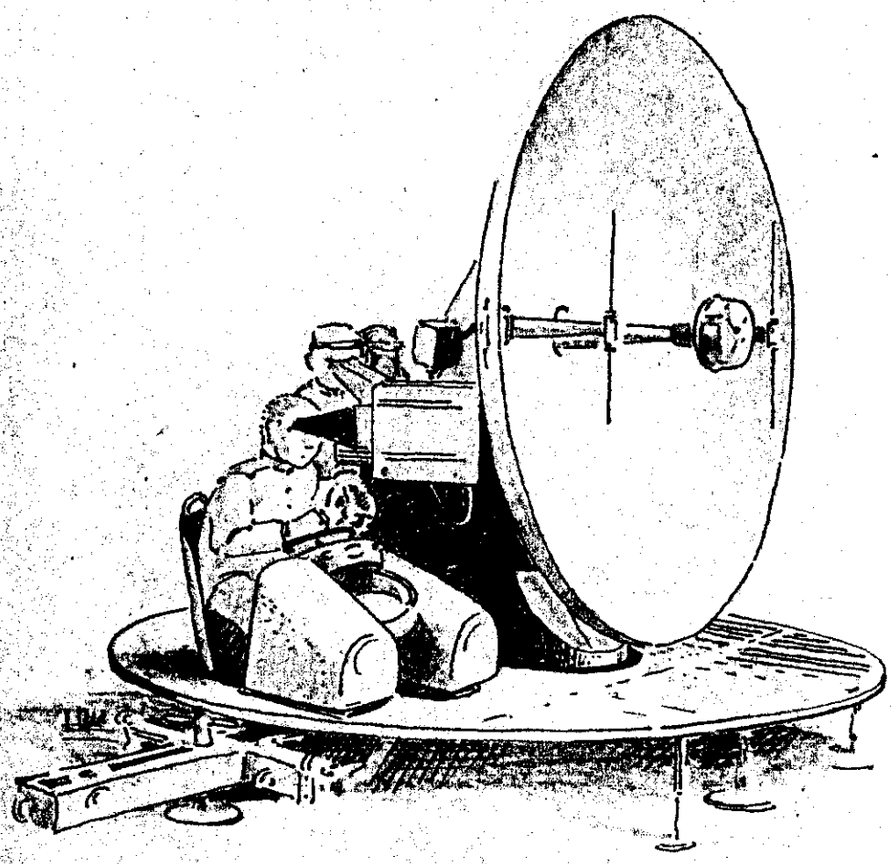


Small Würzburg

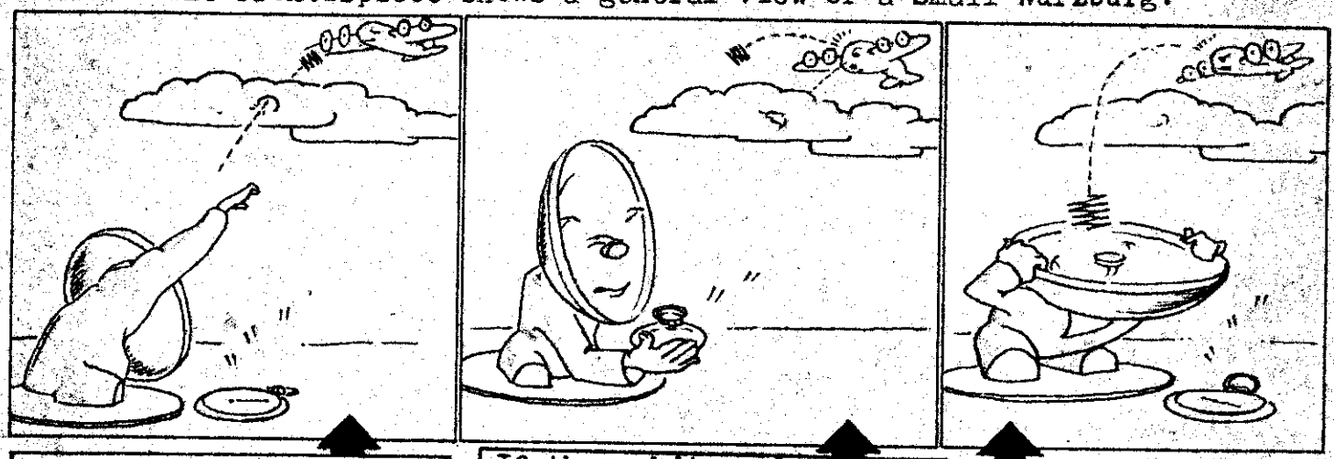
Introduction

The German radar called the Small Wurzburg is the instrument which is used to lay flak batteries on our planes when they are obscured by clouds. If it is not interfered with, it can give the azimuth and elevation of a formation of our planes to .2° and can give the range to about 60 feet. Even when the planes can be seen, its range accuracy may be preferred to that obtained by optical means. The importance of trying to prevent its use is very evident. The purpose of this booklet is to show briefly and with illustrations how the Small Wurzburg is used and one common way of jamming it, namely by the use of Chaff.

Another method of jamming the Wurzburg is the use of Carpet, a special radio transmitter carried by our planes. This important countermeasure is discussed in a parallel booklet.

The Wurzburg

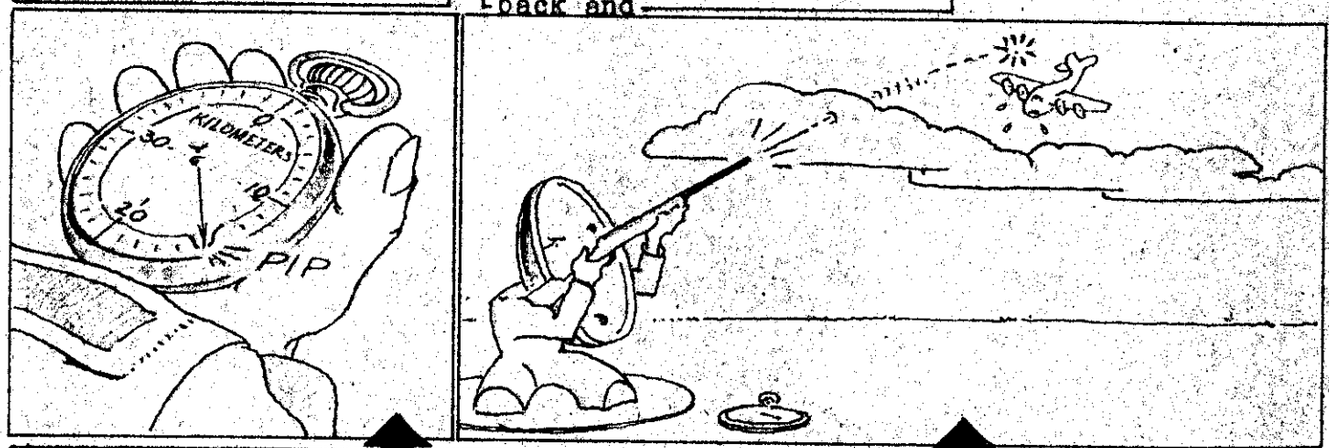
The frontispiece shows a general view of a Small Wurzburg.



The large bowl sends out a narrow short beam of pulses of radio waves.

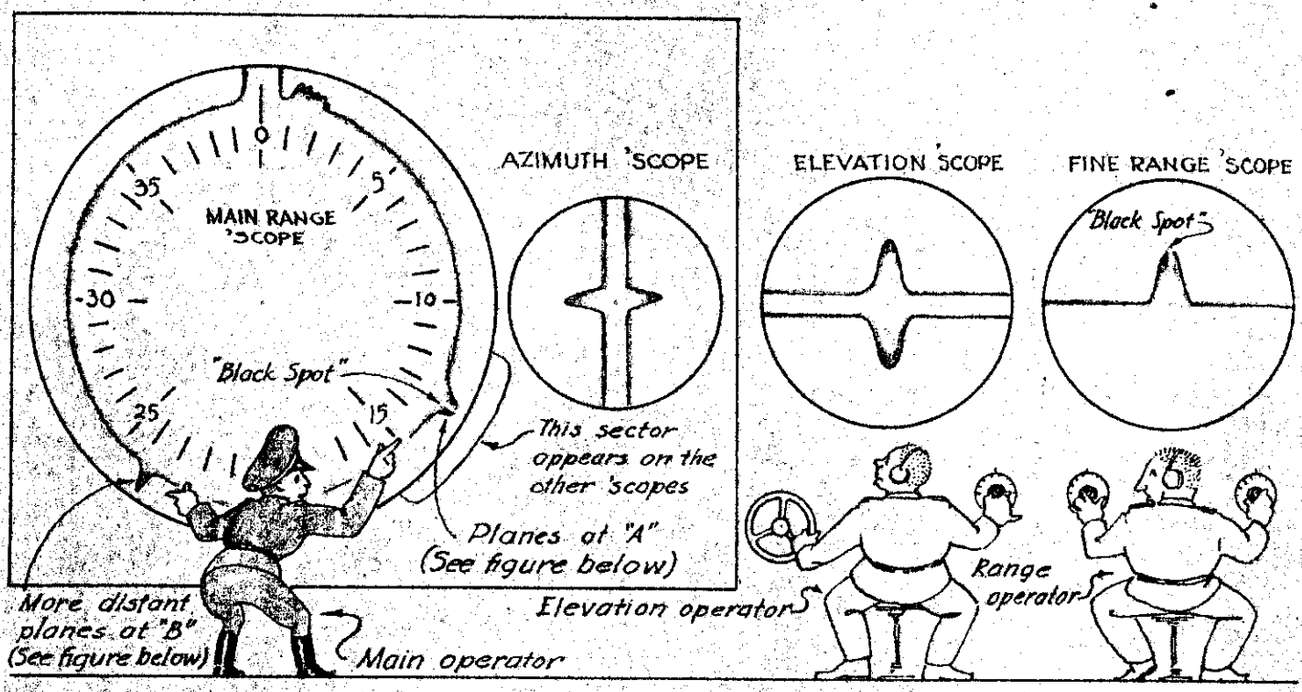
If these hit a plane or formation of planes, some of the signal is reflected back and

caught by the radar set.



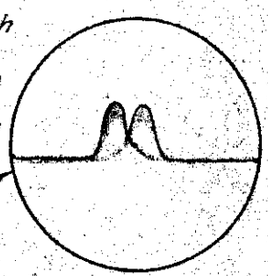
The time required for the echo to return, measured electronically, gives the range. The echo shows as a "pip" on the radar 'scope.

If it is not interfered with, it can give the azimuth and elevation of a formation of our planes to .2° and can give the range to about 60 feet.



A small portion of the trace on either side of the "Black Spot" (a small blank spot in the trace) is shown on all other 'scopes. The main operator tells the range operator at what range to set the "Black Spot."

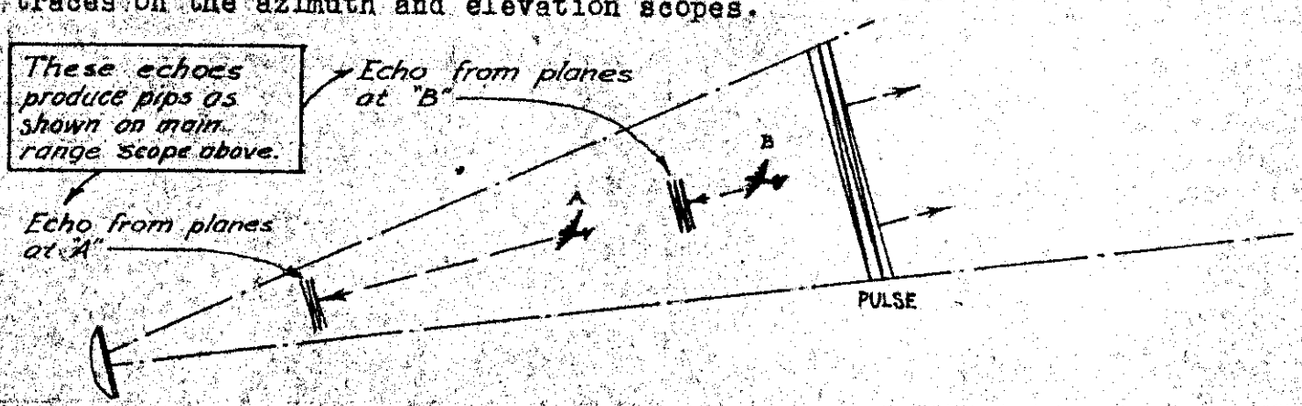
NOTE: The Elevation and Azimuth 'scopes are shown with "Fakir" (back-to-back) which is much less susceptible to Chaff jamming than the original method which was like this:



SMALL WÜRZBURG 'SCOPES

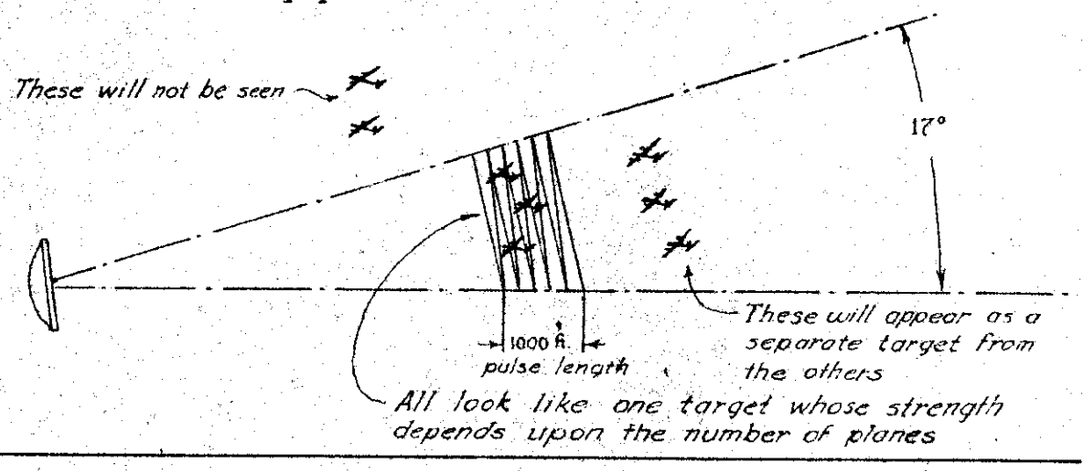
Showing pips from two targets, as indicated below

Three operators are required, the main operator, an elevation operator, and a range operator. The various scopes seen by each operator are illustrated which shows the effect of two formations at different distances. Accurate pointing is done by matching the pips on the two traces on the azimuth and elevation scopes.



It should be noted that the Wurzburg does not include a PPI scope such as is used on many of our radars and which shows a map of the locations of all targets on the scope.

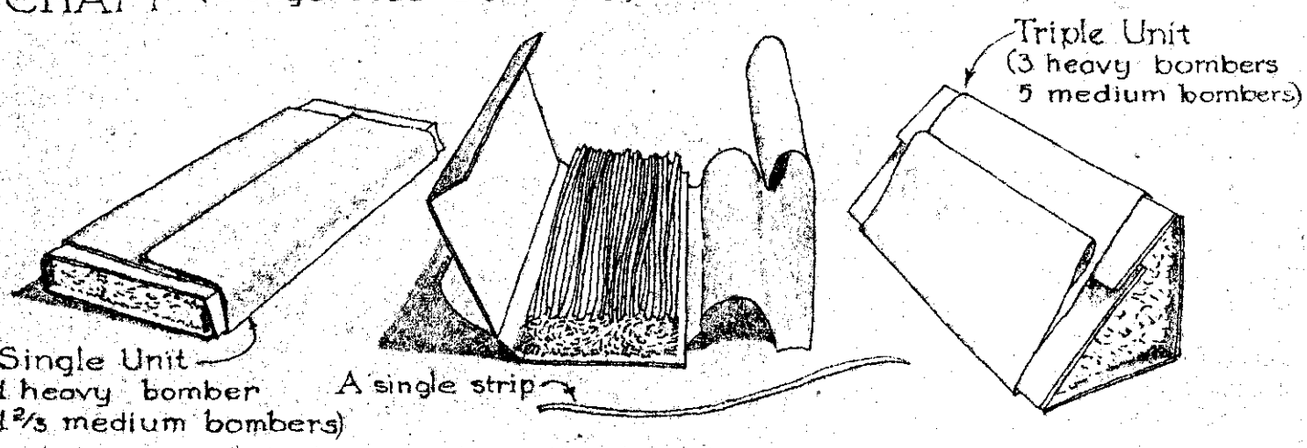
Although direction and range can be determined very accurately, the effective beam width is quite large (17°) and two targets must differ in slant range by at least 1000 feet to be seen as separate targets. This last figure is the result of the fact that all the planes in one pulse length of 1000 feet simply contribute to the same echo. Consider two planes, one about 1000 feet further than the other. The echo from the first plane will just be ready to die away when the echo from the second comes along. The result is a larger single pip instead of two pips.



Window

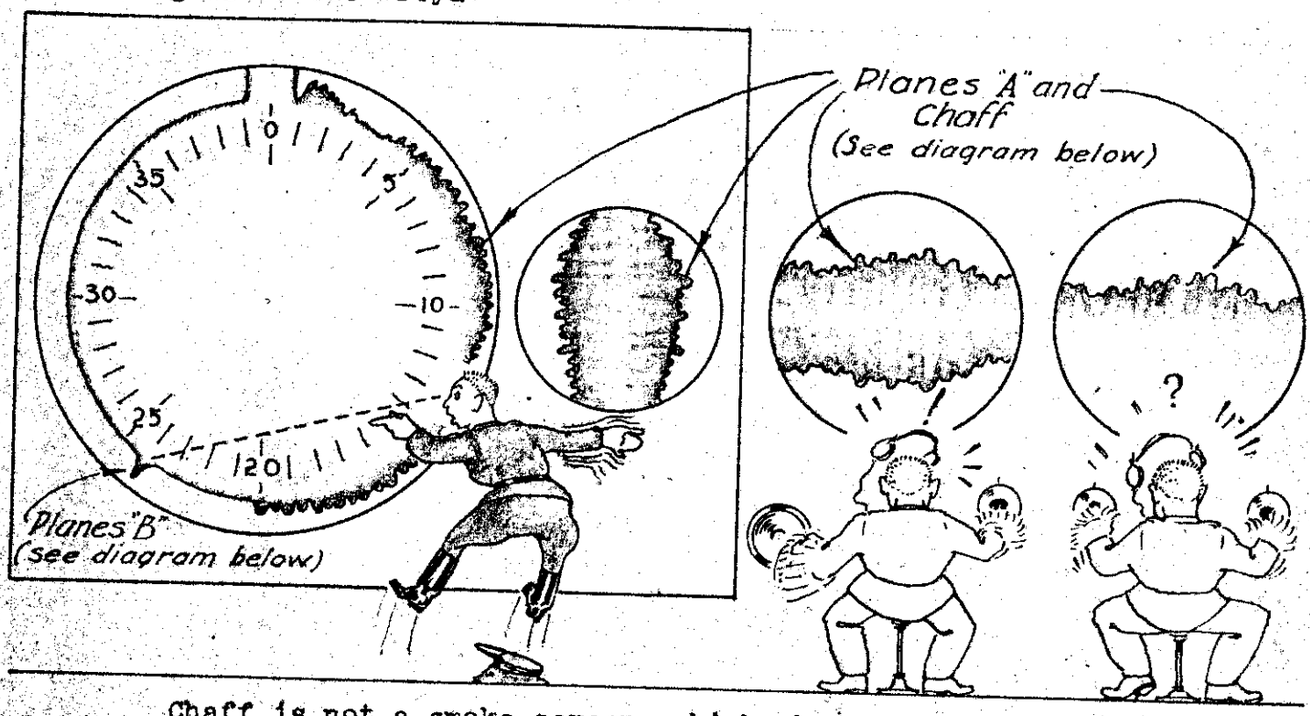
Window is a device which will produce a radar echo similar to that produced by a plane. The most common form of Window is Chaff. There are several types of Chaff but all are essentially the same. Chaff consists of long narrow strips of metallic foil which are cut to a length which is about one-half the wavelength of the radar. Some types are made of plain foil and others are backed with paper. The former, and more recently developed type, is more compact and lighter in weight. A large number of these strips (2000-6000) are packaged so that they will disperse to form a cloud when they are properly dispensed from a plane. It is this cloud of strips which gives an echo like a plane. Two sizes of packages are used. One contains enough strips to imitate one heavy bomber and is called a single unit. The other contains enough strips to imitate three heavy bombers--a triple unit.

CHAFF ("Dehydrated Bombers")

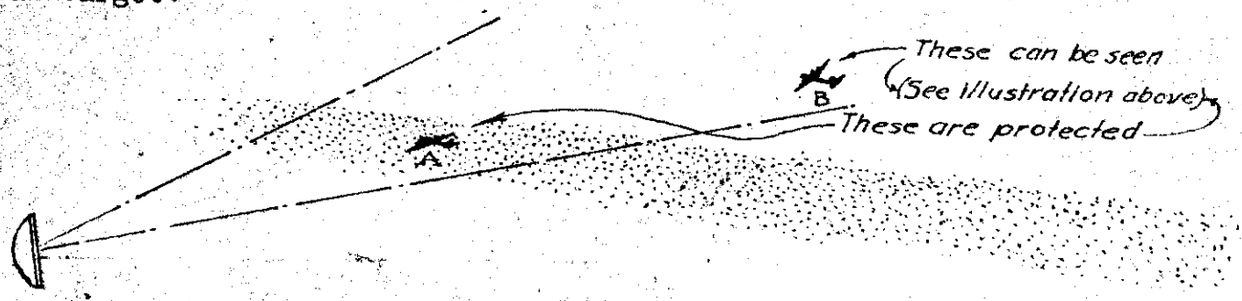


Chaff will work well over a band of wavelengths near the one for which it is cut. CHA-3 covers much of the wavelength band of the Wurzburgs, and CHA-28, which contains strips of two different lengths, covers the complete band now used. If a still wider band coverage is needed, CHA-25 is also available. It is a mixture of three lengths.

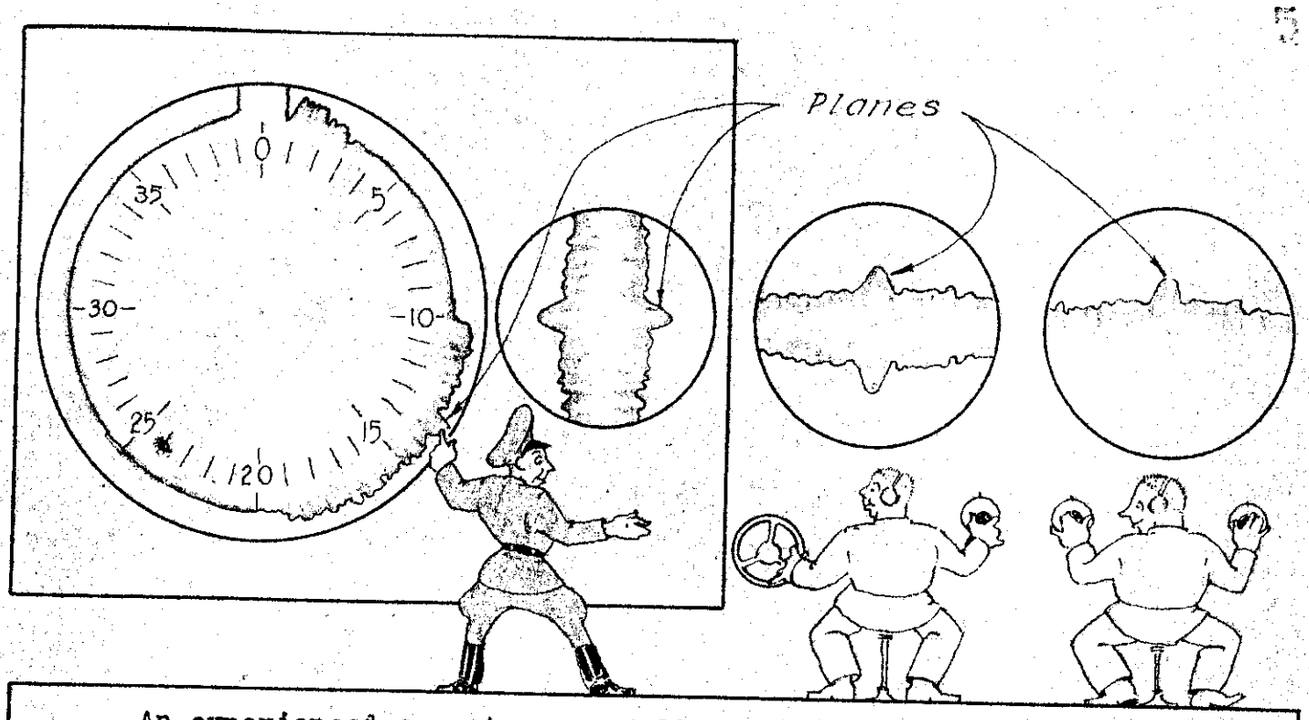
Another form of Window is called Rope. It consists of 400 foot rolls of ½ inch wide aluminum foil attached to a small paper parachute or cardboard square by a short length of cloth tape. It will work best against radars which have a long wavelength, such as the 2 to 3 meter wavelengths of the Freya.



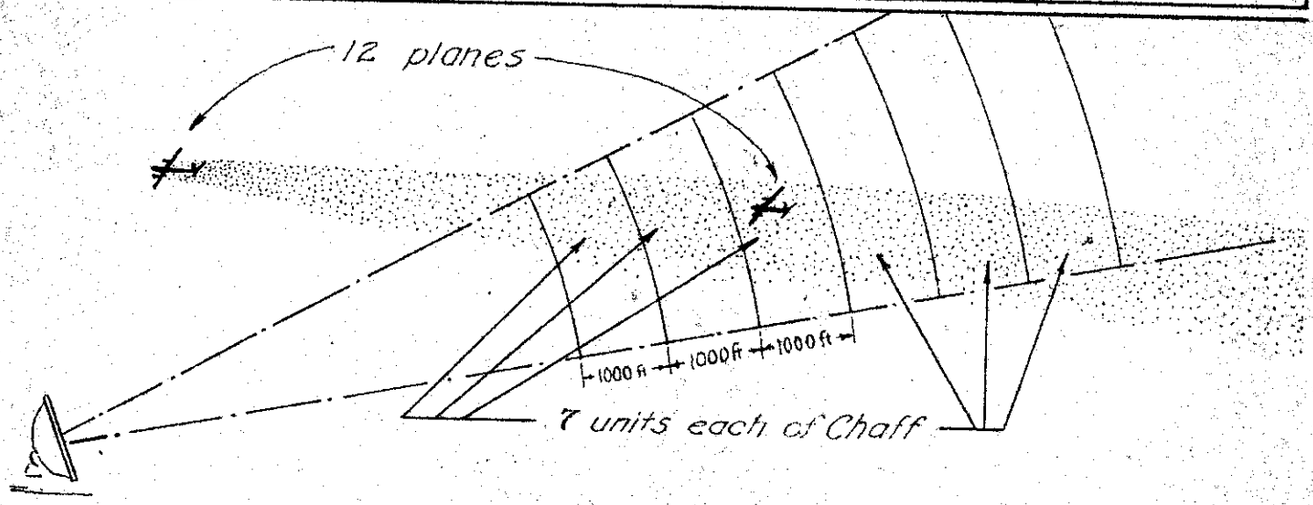
Chaff is not a smoke screen, which obscures all objects behind it from the "sight" of the radar. Instead it serves as a radar camouflage by sending back so many echoes that the radar cannot pick out the real target.



If Chaff is to cover a formation, two things must be accomplished: Enough Chaff must be used to produce pips as big as that of the formation and there must be no extensive gaps between the Chaff pips. The reason for the last is that the pip due to the planes will move along the scope much more rapidly than the pips from Chaff.



An experienced operator can follow such a moving pip through gaps which are the result of a shortage of Chaff.



Since all our formations are tight enough to be included in a pulse length of 1000 feet, it is easy to figure the amounts required. There must be 3/5 of a unit of Chaff for each plane in each pulse length. If each plane dispenses 3/5 of a unit every 1000 feet (12-15 units each minute) this will give the desired concentration for the formation following it. The desired condition is illustrated in the above diagram.

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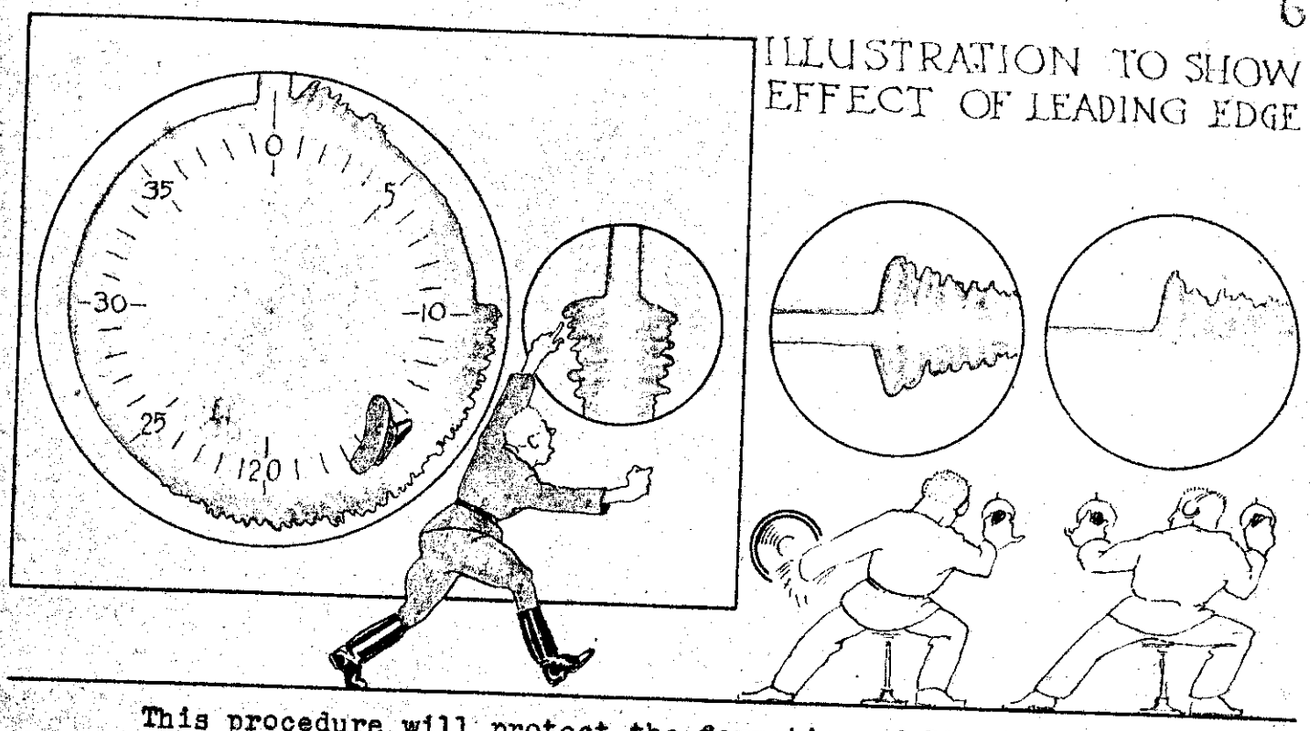
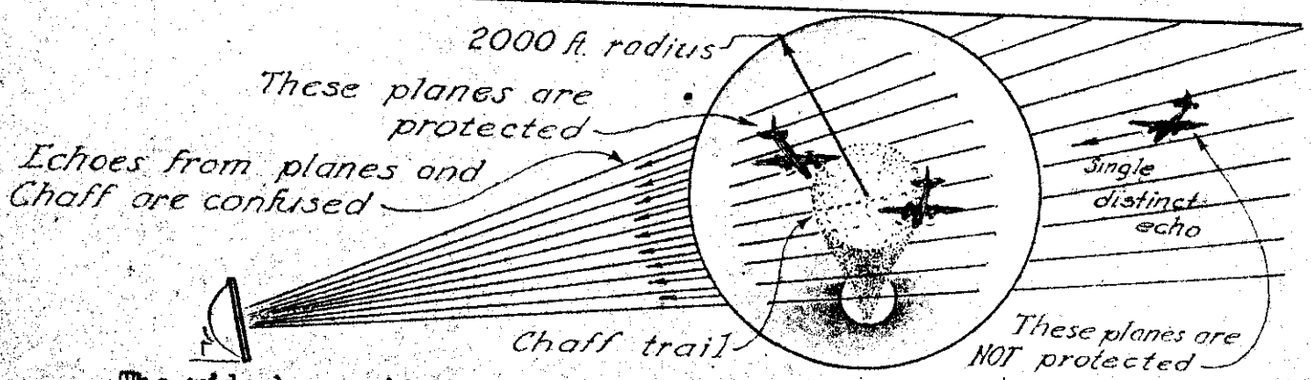
ILLUSTRATION TO SHOW EFFECT OF LEADING EDGE



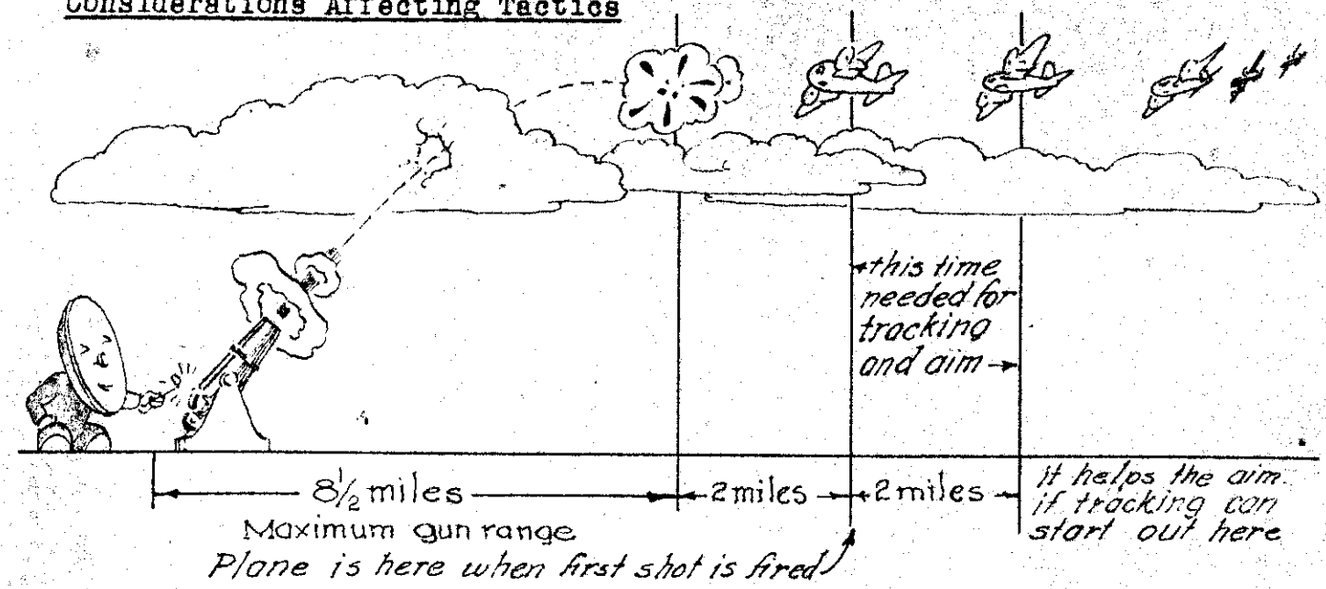
This procedure will protect the formations following in the Chaff trail but will leave the leading formation comparatively unprotected except for a decrease in the accuracy of plotting. As the leading formation approaches the radar it is the nearest object being "looked at" and, hence, can be picked out by looking at the beginning of the Chaff trail. However, experience shows that operators cannot do quite as good a job of pointing when this leading group is dropping Chaff. The radar tends to "look" behind the formation.

Various methods for laying a trail in advance of the leading bomb formation are being used or are under consideration. These all involve the use of a few faster planes ahead of the main formation. Examples are: (1) Special "Chaff ships" which peel off ahead of the formation; (2) Mosquitos equipped with automatic dispensers; (3) Fighters dropping Chaff-loaded bombs or gas tanks.

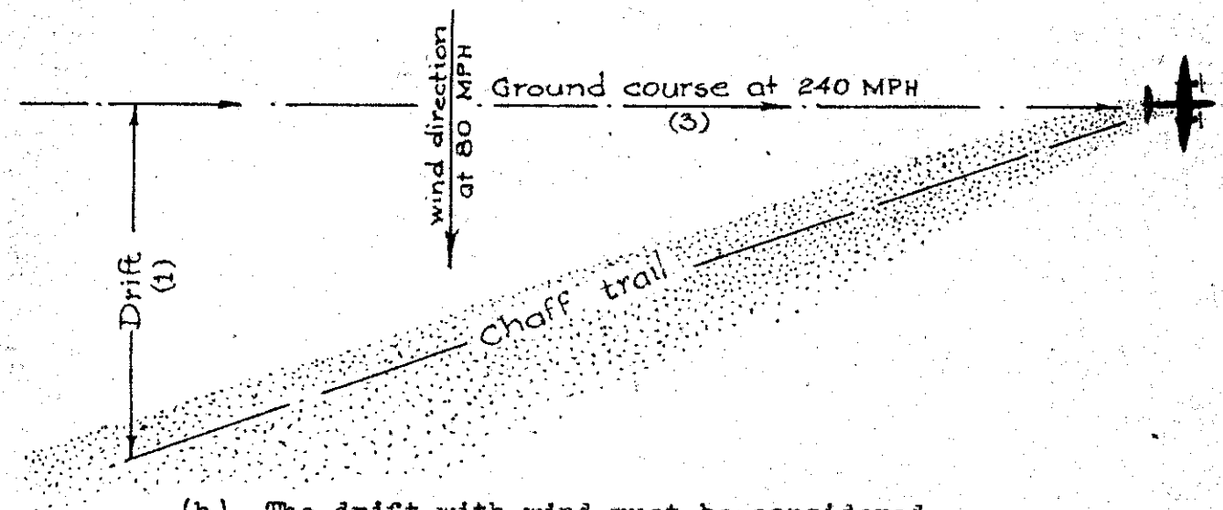


The wide beam width, along with other factors of the Wurzburg, tend to make the region protected by an extended cloud or trail of Chaff larger than its true volume. The best estimates now place the figure to include all the region within about 2000 feet from the center of the trail.

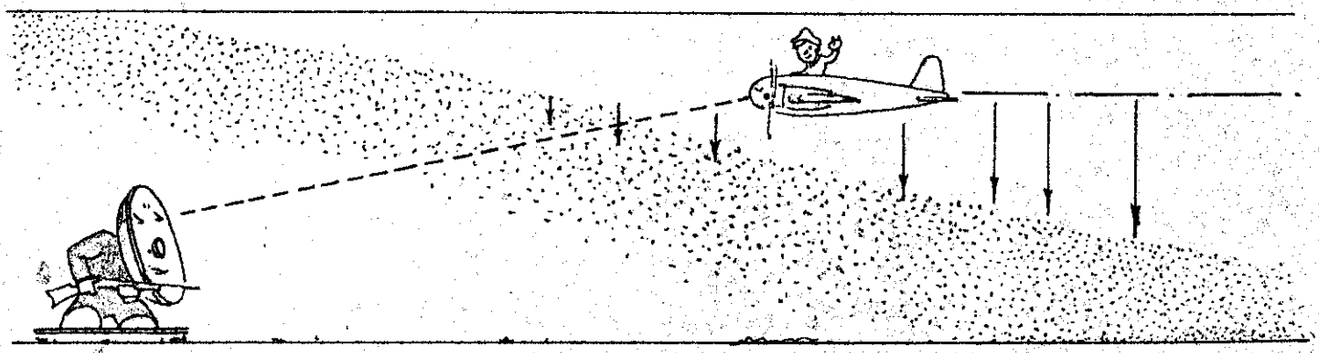
Considerations Affecting Tactics



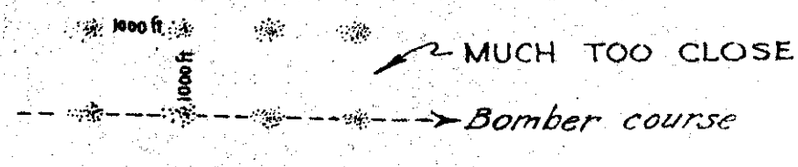
(a) The Wurzburg can "see" a big formation out to 25 miles, but the crucial tracking region is the range within 12 miles.



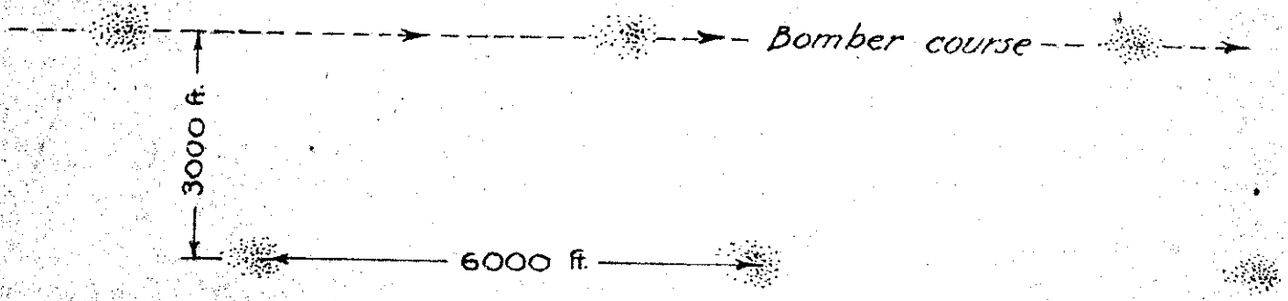
(b) The drift with wind must be considered.



(c) The rate of fall of Chaff is 400 feet per minute. If Chaff is dropped 10 minutes in advance, it will have fallen 4000 feet.



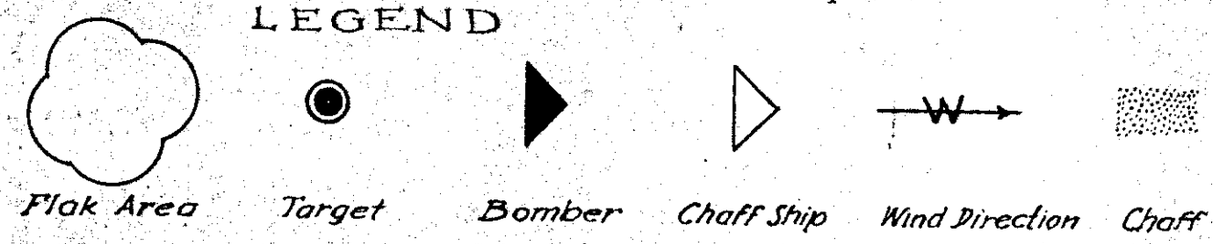
MORE USEFUL SAFE SPACING



(d) Chaff is sometimes dispensed in large clumps by Chaff bombs or modified gas tanks. In such cases the clumps should be spaced to give a maximum coverage. A spacing of 6000 feet is almost certainly not too wide a spreading for tanks holding several hundred units. If bombs holding only about 150 units are used, a closer spacing may be desirable. In any case, at least the density called for on page 5 should be maintained.

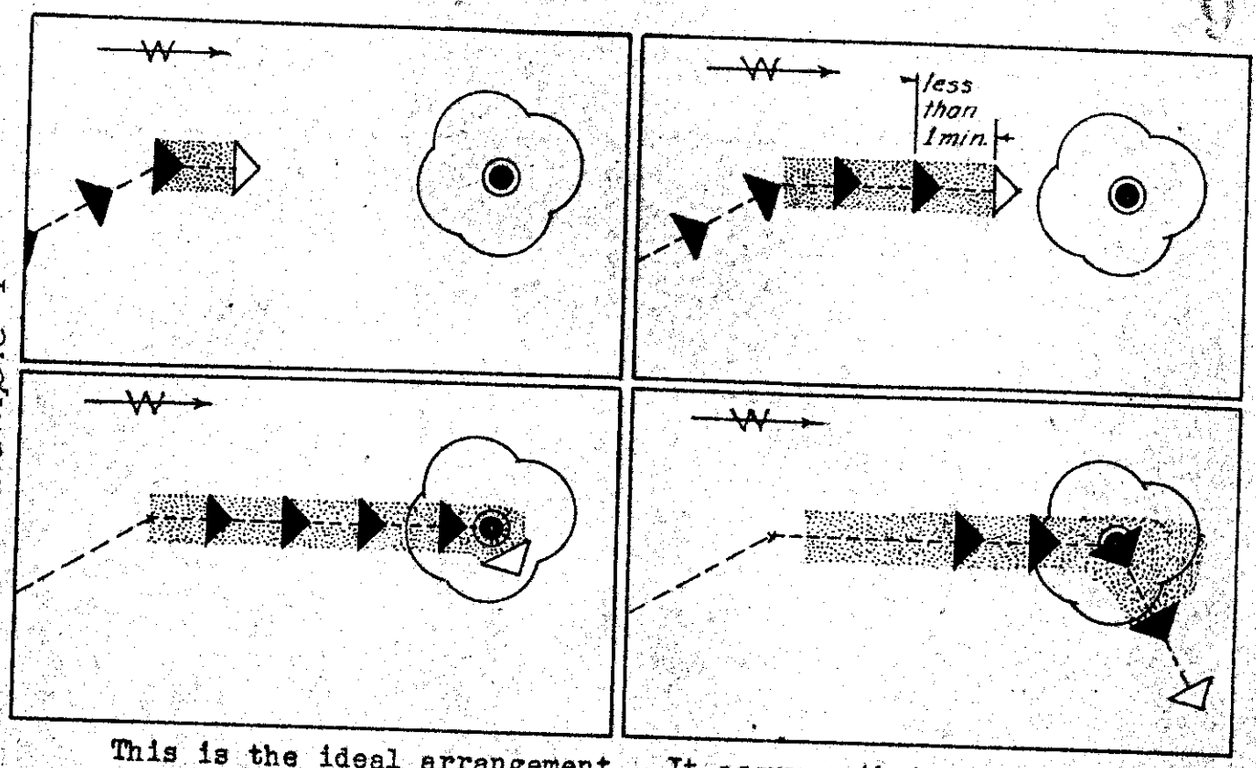
Examples of Tactics

Some examples of Chaff tactics are given below. The examples and the comments are only given to illustrate certain points. Tactics to be used will, of course, differ from these in many ways and in fact should not become too stereotyped. Chaff is a medium with great flexibility and with many possibilities for deception.



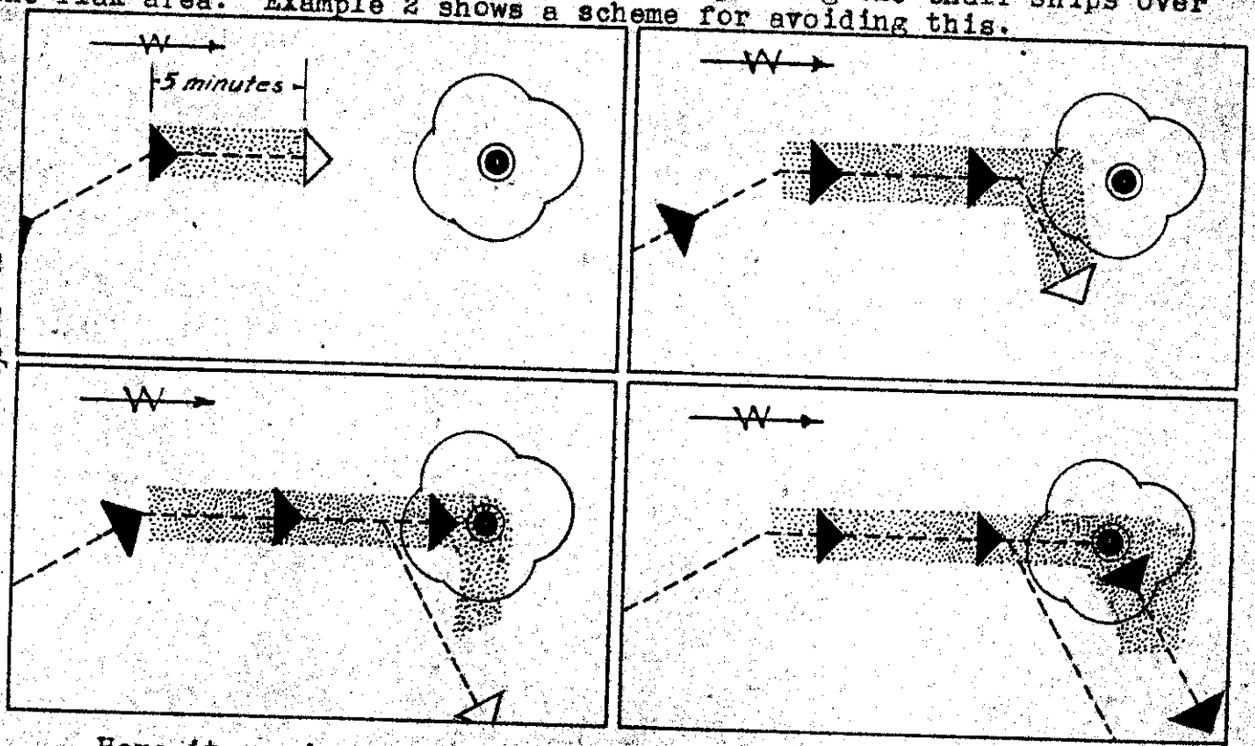
The special "Chaff ships" may be bombers equipped with extra chutes to enable rapid dispensing or else Mosquitos or fighters with automatic Chaff dispensers.

Example 1

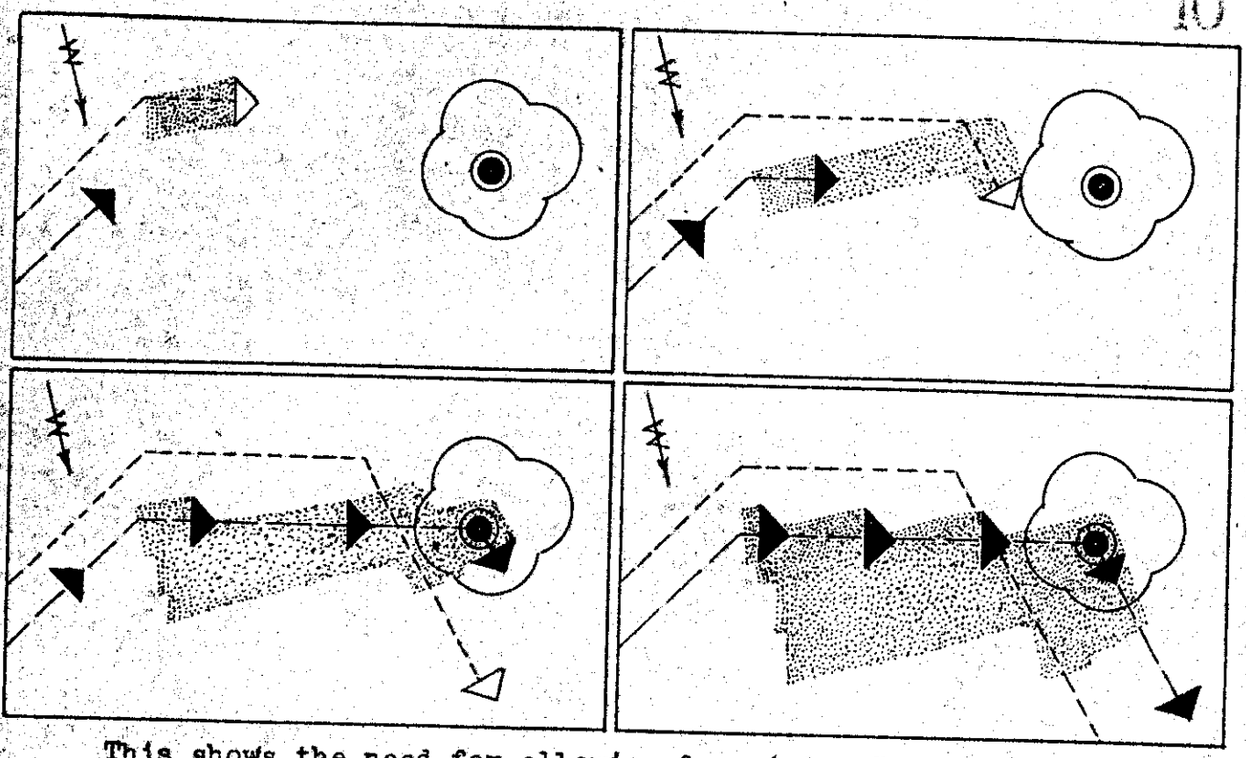


This is the ideal arrangement. It assumes that the bomb run is downwind and the succeeding squadrons or groups follow the same course. It further assumes that one dares to risk putting the Chaff ships over the flak area. Example 2 shows a scheme for avoiding this.

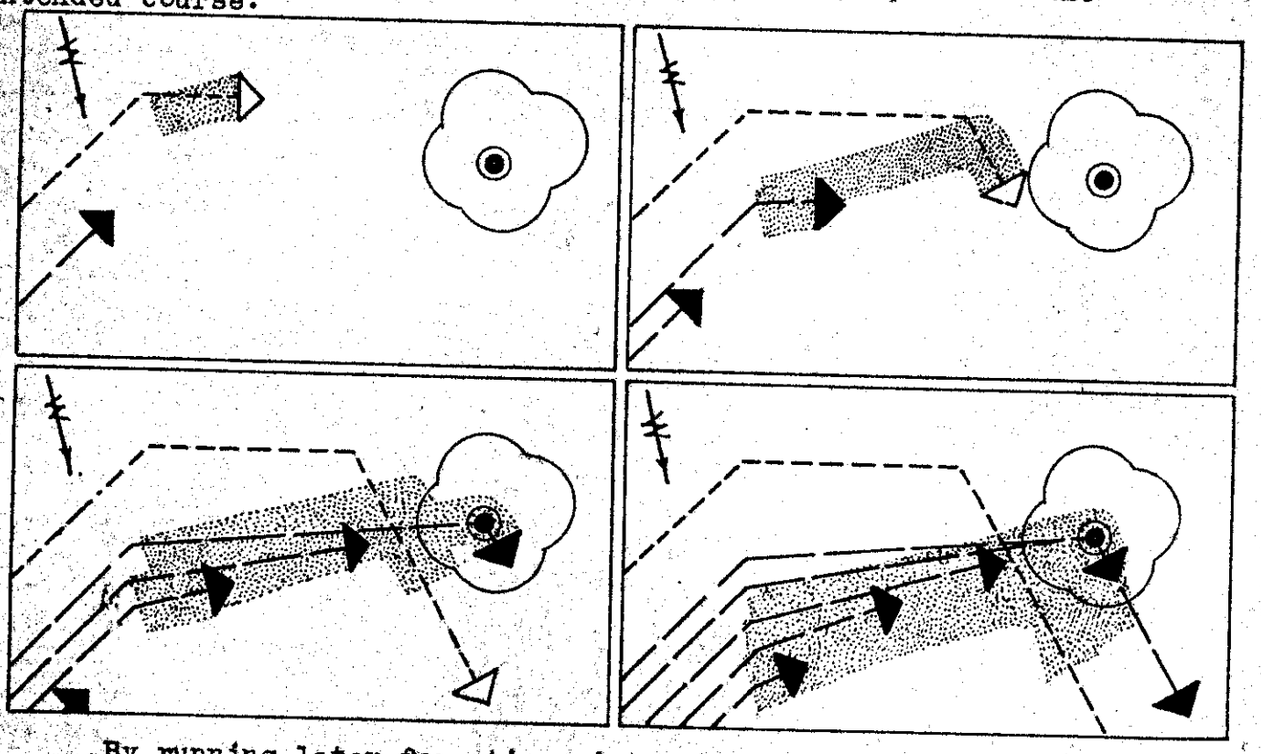
Example 2



Here it can be seen that even though the Chaff ships cut off before the flak area, their Chaff may blow down towards the target, thus extending its protection to the leading formation.

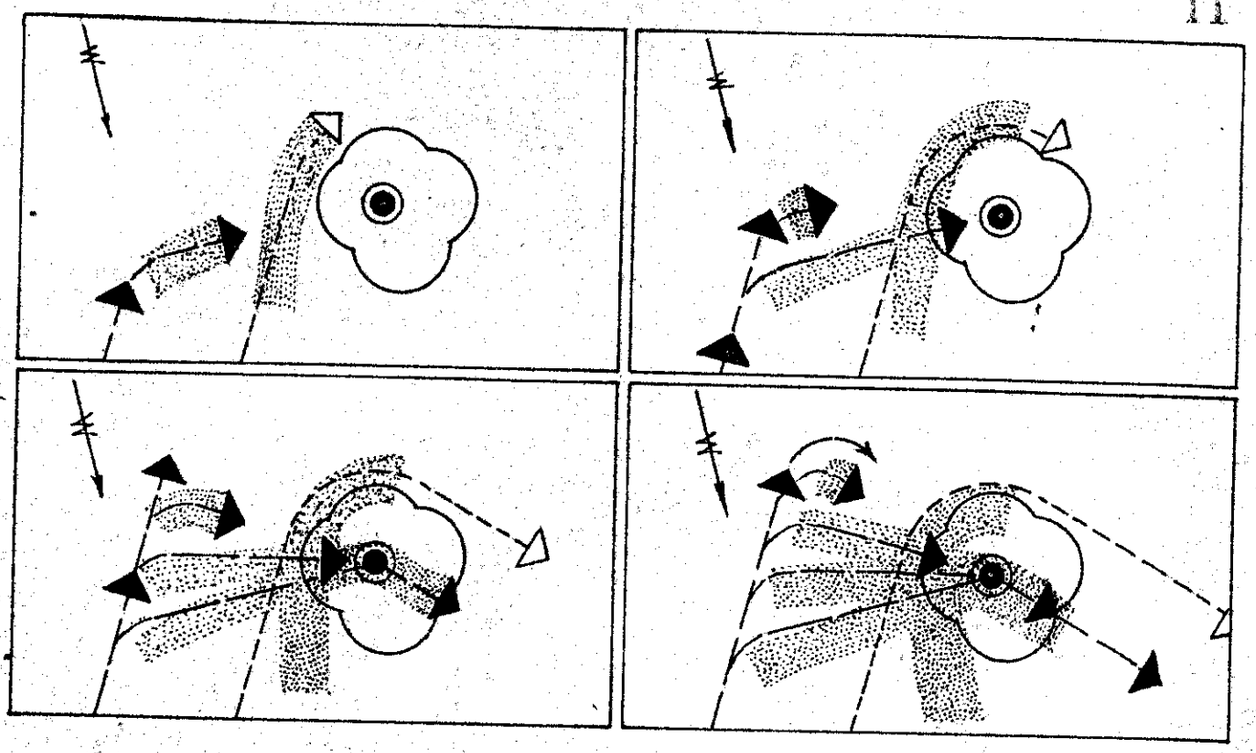


This shows the need for allowing for wind. It is also apparent that this system has danger of leaving later formations unprotected, especially if they should tend to fly upwind of the intended course.



By running later formations in on the downwind side of each preceding run, an improvement in coverage can be made.

Example 5



This use of a "screening force" will cover only a small portion of the bomb run. One must remember that all of the run 4000 feet to the left of the Chaff trail as well as the portion between the trail and the radar is not protected. It is very easy to misjudge the wind with the result that the effectiveness of the Chaff may be largely lost. On the other hand, if Chaff is properly placed, it will allow for considerable variation in the bomb run.

The most likely worth of this maneuver is in the possibility of deception. The radar operators may concentrate on the leading edge of this Chaff trail or spend their time searching in other parts of it, and hence fail to track the bomb formations as they come in. Such effectiveness depends largely upon the failure of the ground warning system which could keep the Wurzburg from wasting its time on this diversion.

Comment

One of the most difficult problems in using Chaff ships for protection of the leading edge is to get the Chaff properly placed and timed. For this reason it seems that schemes such as Examples 1 and 2, with some sort of direct contact between the Chaff ships and the leading group, are to be preferred. This does not mean that the use of tactics such as that of Example 5 should be ignored. Intermittent use of it may make it valuable, especially for its value as a means of creating confusion.

Summary of Rules for Chaff

(1) A radar can see through a screen of Chaff but cannot detect or track planes which are in or near the Chaff trail.

(2) To cover an N plane formation, 3/5 N units of Chaff should be dispersed per 1000-2000 feet. This is equivalent to N units every 5-10 secs.

(3) The protection of Chaff extends about 2000 feet.

(4) Chaff blows with the wind.

(5) Chaff falls 400 feet per minute.

(6) The protection of a formation of planes dispensing Chaff but not flying in a Chaff trail is limited.

Chaff and Carpet

Chaff and Carpet supplement each other in a very effective way. One of the principal difficulties with Carpet is that some of the Wurzburgs may not be covered by the jamming. In such cases the presence of Chaff is a big help. On the other hand, Carpet will undoubtedly help make up for the occasions when Chaff does not give sufficient protection. An example of this is the case of leading edges.

Anti-Jamming

A final comment should be made on the fact that German engineers have devised various methods to decrease the jamming effect of Window. The success of these is not completely known. At most, they may call for new tactics and increased amounts, possibly twice to three times the amounts indicated above.

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