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## **Camouflage on the Oil Front**

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**Potentially every industrial installation in the United States is a target for Axis bombs. This particularly applies to all facilities for the production, transportation and refining of petroleum as the war effort is dependent on a continuous supply of fuel.**

**In this article the general principles of camouflage are discussed as well as their application to buildings and equipment used in the oil industry.**

CAMOUFLAGE is a weapon of war. It has an ancient history that finds its roots in the desire of the hunter and the hunted to baffle their opposition during predatory maneuvers. Men and animals have always looked to forms of concealment or confusion to protect themselves and to surprise the enemy. Indians on the warpath used to paint and feather themselves to merge with their surroundings and Daniel Boone counselled frontiersmen to dress the color of the leaves.

Until the introduction of the airplane instruments of war were concentrated along the battle fronts, but since the advent of the airplane and the concept of total war the fronts have been replaced by larger fields of activity; and will undoubtedly before this war is over increase in their size to include entire countries. (See Alexander de Seversky's "Air Power.")

Anything associated with man has become a military target and requires, therefore, military means for its protection. In accordance with the characteristics of total war all nations involved recognize the vital importance of maintaining their means of production at a high level of activity by guarding them against attack.

Today war can be won or lost by oil. Oil is needed by the Army, the Air Force and the Navy, and there can be no group in the United States more interested in the protection of its property and the assurance of its ability to supply the war effort than the producers, refiners and distributors of the oil industry. The Navy has announced convoys for tankers along the coast, but there are no convoys for oil from the Christmas tree through the pipe line, refinery and terminal to the tanker. Yet the oil must be protected, and the principal way to do it is by the use of camouflage.

As it is impossible for every individual property, large or small, to be provided with airplane and anti-aircraft units for its protection, camouflage assumes a crucial importance for the owner of a field or refinery. This is particularly true of owners of oil properties where the installations are spread over great areas. The oil man has nothing to do with airplanes and artillery; when such appear they are selected, provided and maintained by the Army and Navy. The oil operator does choose and install, subject to the approval of the Army district engineer, some scheme to keep his property from making a good target for the enemy.

In most other countries the property owner does not have this responsibility, but national attitudes toward camouflage vary from government to government.

### **Central Control of Camouflage**

The British have, after long and acrimonious debate (see discussion in *Nature*, London, from June through November, 1940), rationalized their camouflage program under government auspices so

that the large and most important plants are camouflaged by governmental departments, while the small plants shift for themselves.

The Nazis inherited along with the traditional German military machine a feeling for camouflage on the grand scale which found its earliest expression on the western front during the first World War in the complete coverage of square kilometer after square kilometer of villages and roads by false fields, paths and houses that concealed beneath them the traffic of war and the congregation of troops for secret offensives. The enormous camouflage installations at Hamburg and Berlin today show how much value the Nazis attach to camouflage as a military weapon. Camouflage in Germany is in the hands of the Organisation Todt, formerly headed by Todt, (the engineer who built the Autobahnen and the West Wall, and who died recently), and now headed by Speer. The Organisation Todt is a large public corporation devoted to grandiose engineering projects; it is very close to the regime.

In Russia the serious study of camouflage theory and practice received its greatest official impetus in the early 1920's through the founding of a school for camouflage at Moscow, the good results of which have been evident in German communiques complaining about the difficulties with camouflaged Russian airfields.

The Japanese are able and ambitious camoufleurs, and the Dutch are supposed to have held out as long as they did in the East Indies only because of their excellently camouflaged air fields.

Targets have been missed by British, Germans, and Japanese because of skillful and properly executed camouflage. A recent newspaper report tells of the partial failure of an American bombing mission in Rumania in trying to locate well camouflaged oil installations near Ploesti.

Poorly camouflaged objectives, however, can increase the danger of attack as the Germans discovered in their colossal attempt to camouflage the Binnen Alster.

It should be added that camouflage is not effective for mass raids such as those that took place on Cologne, Duisberg, Lubeck, but the probability of attacks on an overwhelming scale on American targets, even should the enemy temporarily occupy nearby bases, is very small.

In the United States it is only slowly that some idea of the importance or even the specific nature of camouflage is being grasped by those most concerned - the owners of industrial properties.

This failure may be ascribed to a plethora of irresponsible accounts in the popular publications giving the impression that camouflage is a sort of hocus-pocus without rational basis, and the extreme scarcity of intelligent and serious discussions such as the one that appeared in the March 1942 issue of *Fortune*. But given an awareness of the value and importance of camouflage, what can the property owner do to provide his plant with camouflage protection? Just as he would go to an architect to design his buildings, he must go to a camouflage expert to plan his camouflage.

Certain inexpert camoufleurs have recommended painting tops of oil storage tanks black and dark brown, colors which any oil man knows V absorb the long (heat) rays of the sun and cause evaporation. In one instance a so-called camouflage expert recommended that cinders be placed on top of oil tanks and in the fire breaks; he did not understand the harmful effects of cinders around oil installations. A competent camoufleur would have known that camouflage paints have been developed which under infrared photography reproduce just like natural foliage; these paints reflect the long (heat) rays and are as good for oil tanks in many instances as white or aluminum color.

The camouflage expert can never be an individual working alone. He should be one of a staff whose fields of knowledge embrace architecture, engineering, psychology, topography, botany, physics, mathematics, design; and all this knowledge must express itself practically in terms of the immediate problem so that each field acts as a check and coordinate for the others. For example, if during the first planning conference, it is suggested that certain structures or trees would be useful, the engineer or botanist might find it impossible to erect those structures or plant those trees on or near buildings to be protected. Other suggestions would then be made.

The first thing the camouflage staff does is to visit the plant and note carefully its plan and elevation and its relation to the landscape and local topography, its pattern of typical activity, that is, the circulation of traffic in relation to it, and the hours of influx and outflux of the personnel, its arrangements for parking cars and trucks, and its working activities such as emission of smoke, light and flame. Also to be noted at this time are details such as the type of construction of the walls, roofs and windows so that the paint and structure later to be recommended will be suited to the kinds of existing surface.

### **Use Aerial Survey**

The staff then makes an aerial survey of the terrain, carefully observing characteristics and peculiar features for a radius of at least 10 miles around the plant; particular attention is paid to landmarks that might serve to give an enemy airplane bearings upon its target. Topographical patterns and colors are recorded personally by the camoufleurs and also by the camera using both panchromatic and color film and both in plain and stereoscopic series from four points of the compass, looking up sun and down, and from oblique and vertical angles at various altitudes up to 10,000 ft.

Color is important in camouflage, but tone is of greater importance. Even these, however, are secondary to a complete understanding of the shadow problem, as all colors begin to gray at 15,000 ft., and at 25,000 ft. no color can be seen from the air except as a gray. This is particularly significant when it is recalled that most aerial reconnaissance takes place between 30,000 and 40,000 ft. While shadows do not have a great effect on the eye at 5,000 ft., the higher one goes the more they seem to sharpen. Many small objects such as hillocks and buildings can be easily defined at 30,000 ft. when the eye no longer recognizes color.

### **Make Scale Model**

The staff next prepares a scale model of the target and its surroundings by pooling all the notes and information they have collected individually according to each one's specialized knowledge. The importance of models is known to the expert camoufleur and no camouflage expert will work without a heliodon as the shadow patterns will influence most strongly the kind of design that is developed.

It will then be decided whether it is possible to conceal the plant entirely or partially, or whether it would be best to resort to confusion. Total concealment is most often out of the question but partial concealment is in many instances just as efficacious, while confusion is often the only solution. It is of these two types of camouflage that the man walking along the street says: It isn't camouflage, I can see it. In both conditions recognizable features of the landscape are made to disappear by painting appropriate design and tone to the landscape and by the use of structures which change the contours of the target and break up or transform its shadows. Partial concealment might not operate below 6,000 ft. or it might register as a camouflaged object on photographs, but it would still serve to make the bombardier uncertain and spoil his aim. The bomber's angle of recognition of his target

is about 30°, that of the dive bomber is about 55°. It is, therefore, more important for the camouflage to be fully operative at oblique angles than at the vertical.

If it is impossible or silly to attempt to make a plant disappear into its surroundings, and this would be so where a plant is located in the midst of several square miles of industrial installations (such as pumping equipment one sees in Illinois, Oklahoma and Kansas), or on a small island of which it is the main feature, confusion must be employed so that the enemy, although, knowing where his target is, cannot isolate it with certainty and destroy it.

Confusion may be created by obliterating landmarks which lead to the objective with paint, structure or smoke screens, and by making the objective a peripheral element of a large, abstract design, or sometimes even concealing it separate from the design. The design is created to attract attention to itself, and if the target is not part of it, is a small part of its margin, there is a good chance that it will avoid direct attack. Many such systems are known, but the best known, is the use of poorly camouflaged dummy plants at a safe distance from the real objective.

Exhaustive tests follow completion of the design in model form, and when nothing is left to be desired, plans and color charts are prepared for execution of the actual painting and construction.

### **Petroleum Camouflage Problems Different**

There are camouflage problems arising in the oil industry which are extremely difficult - East Texas for instance. It may be impossible to camouflage thousands of wells, but it is entirely possible to camouflage and so protect the important refineries. Refineries and docks are not hard problems. Pumping stations are simple things to camouflage, and as all oil men know, pumping stations are the heart of a pipe line, and for an enemy to destroy a few of them on an east-west pipe line would impair the whole line. A complicated area such as East Texas is impossible to camouflage by paint and structure alone, but there are other means of concealment for oil installations which would give a high degree of assurance against important damage being done.

Camouflage is highly complex work that requires the combined skills of a group of men, expert in their fields. Col. Homer Saint-Gaudens, camouflage officer on the staff of the chief of engineers, who is dean of camouflage in the United States, summed it all up in the title of a recent article on camouflage; the title was "Not by Paint Alone". If owners of future targets had the responsibility of providing airplanes and anti-aircraft batteries for the protection, of their property, they would seek the advice of experts in these weapons. Camouflage is the only means of protection left to the decision of the owner. He must be sure that he gets the best for his money for camouflet, a word cognate with camouflage, is defined as "a stinking composition blown into the face of the enemy". If camouflage is left to the inexpert the probabilities are that many "stinking compositions" will be conceived.