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Preliminary Report on Dazzle Camouflage of Ships

by

Charles Bittinger
E. O. Hulburt

NAVAL RESEARCH LABORATORY
BELLEVUE, D. C.

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Preliminary Report on Dazzle Camouflage of Ships.

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Prepared by: _____
Charles Bittinger, contract employee

_____
E.O. Hulburt, Pr.Physicist,
Superintendent, Physical Optics Division.

Approved by: _____
H.M. Cooley, Captain, USN,
Director.

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ABSTRACT

Models of various types of passenger ships, a merchant vessel, a cruiser and a destroyer were painted with camouflage designs and were viewed in a laboratory theatre.

Pictures are shown of twenty-five new course distortion designs, eighteen being of an obtrusive character and seven of an unobtrusive character.

Pictures are shown of five American World War designs. They produced very effectively course confusion.

Chapter 1

INTRODUCTION

1. Authorization. The investigation of dazzle camouflage of ships was authorized by Bureau of Construction and Repair letter S19-7 (RI) of 16 March 1936.

2. References. References pertinent to the present report are:

Reference (a) "The Development of Marine Camouflage and Tests Relating Thereto", by Harold Van Buskirk, Lieut.(CC) U.S.N.R.F., May 1, 1919. BuC&R file 14258-A14, enclosure (A) with Vol. 4.
(b) Ibid., enclosure (B) with Vol. 4.
(c) Ibid., enclosure (C) with Vol. 4.
(d) "Marine Camouflage", May 10, 1920, BuC&R file 14258-A14, enclosure (A) with Vol. 5.

3. These references comprise the only written records of the subject available in Navy files. In the Naval Torpedo Station, Alexandria, Virginia, are collected a large number of dazzle camouflage designs.

4. Definition. "Dazzle camouflage" refers to painting a ship in such a way as to produce confusion or deception. There is no precise definition of the term. Deception may be effected in various ways and for various purposes; for example, painting a ship so that its course appears to be different from its **true** course; painting a ship so that it looks like some other ship; and painting large irregular pattern to give a confusing effect. Deceptive expedients by means other than paint, such as changes in superstructure, false, tilted, shifted stacks, masts, etc., have often been classed as "camouflage". Painting in order to lessen its visibility has been described as "camouflage".

5. Scope of the present report. The present report deals only with producing deception by means of paint in the course of a ship as viewed from the surface. Small models less than two feet long of commercial and naval ships were painted and viewed in a small theatre set up in the laboratory. The work is essentially preliminary in that no experiments have been made with ships at sea. It is believed, however, that in general the conclusions derived from the models should be valid for the full scale case. The present experiments have consisted mainly in an extension and development of the experiments of the World War with the introduction of no new or novel ideas except possibly for the idea of "unobtrusive" designs.

6. At the same time the World War experiments of 1918 appear to be of such value that they should not be lost sight of in any contemplated plan of camouflage. Therefore a chapter has been given to the 1918 designs.

7. World War opinion of the value of dazzle camouflage. British Opinion An analysis of ships camouflaged, attacked or sunk by submarines led the British Admiralty to the following conclusions:

> "It is considered that dazzle painting cannot possibly assist the submarine and it is almost certain to increase the difficulties of attack by making it difficult to tell a ship's course,..... provided the masts and funnels do not give all the information desired." Reference (b), page 308.

> "Dazzle painting is of little value to ships in the line, and under certain circumstances may be a positive disadvantage." Reference (b), page 306.

> "It must be remembered that the sole object of dazzle painting is to cause confusion as to the course and speed of a vessel, and that it is not designed to reduce visibility. In our opinion, from a careful examination of the whole of the evidence, no definite case on material grounds can be made out for any benefit in this respect from this form of camouflage.

> "At the same time the statistics do not prove that it is disadvantageous, and in view of the undoubted increase in the confidence and morale of officers and crews of the mercantile marine resulting from this painting which is a highly important consideration, together with the small extra cost per ship, it may be found advisable to continue the system, though probably not under the present wholesale conditions." Reference (b), page 305.

8. Thus we may summarize the British position at the end of the war as (a) against camouflage of ships of the line, (b) not averse to camouflage of other ships in that evidence indicated that such camouflage was not harmful and of no tangible benefit but of only intangible benefit as aiding morale.

9. American Opinion Regarding American opinion of dazzle camouflage the following sentences may be quoted:

> "It is considered beyond doubt, however, that camouflage painting was of distinct value, particularly in the case of large and fast vessels, which might be saved from disaster by the momentary confusion of the attacking submarine commanders." Reference (d), page 184.

> "In the case of vessels of the fleet it was established that dazzle painting would be objectionable for vessels in the line." Reference (d), page 185.

Chapter 2

SUMMARY AND RECOMMENDATIONS

10. Summary of course distortion designs. New designs to produce course distortion were developed which may be classed as "obtrusive" and "unobtrusive" designs.

(a) Obtrusive designs are given in Plates 1 to 5. The obtrusive design aims to produce the deception by bold and distinct pattern. Therefore the observer perceives immediately that the ship is painted in an unusual way and may be expected to infer that the painting is for the purpose of deception.

(b) Unobtrusive designs are given in Plates 6 and 7. The unobtrusive design aims to produce the deception by a pattern which is not noticeably unusual. In this case, if the design is successful, the observer is deceived as to the course of the camouflaged ship and is ignorant of the fact that he is deceived.

(c) The designs of Plates 1 to 7 employ only shades of gray, with no colors, some designs using three shades of gray and some two shades of gray. The three shades of gray are given in Plate 8, the lightest shade being Standard Navy Gray and the darkest shade nearly black. The shades used in the designs of Plates 1 to 7 are evident from an inspection of the Plates.

11. Recommendations. It is recommended

(a) That the fact be borne in mind that the course distortion designs of Plates 1 to 7 were tried on models only and therefore that their effectiveness on ships at sea is not known,

(b) That if any tests at sea were to be carried out, the obtrusive design of Plate 1a and the unobtrusive design of Plate 6a be tested first, for these appear to be among the most interesting,

(c) That all of the 1918 designs now filed at the Torpedo Station, Alexandria, Virginia, be carefully preserved, for no information is available to contradict the view that these designs are as satisfactory as any which can be devised for the desired purpose.

(d) That one of three possible alternative procedures be considered:

First. Collect the World War designs now at Alexandria and without examining them file with this report, and drop the subject. This would leave the subject with the general principles pretty well covered and illustrated, but not in a form ready for quick application in an emergency.

Second. Collect the World War designs and examine each one with care by painting on a model. This would bring to light the nature and value of the designs.

Third. Collect and examine the World War designs. Prepare scale models and drawings of all ships to be camouflaged. With the models work out the actual design, or designs, for each ship and record these designs on the scale drawings. This would leave the subject in fairly complete form ready for immediate use.

Chapter 3

WORLD WAR DAZZLE CAMOUFLAGE

12. Principles of dazzle designs. The following paragraphs quoted verbatim from reference (b) present an excellent summary of the development of ideas of dazzle designs by the Bureau of Construction and Repair during the World War.

13. "Successful designs may be divided broadly into two groups, those which so completely conceal every structural feature of a vessel as to render it difficult to make any estimate whatever about the course of a ship, and those which depend upon an ingenious use of pattern to give the impression of a course quite at variance with the true course. All good designs of the latter group rely upon a distortion of perspective or an apparent alteration of form to achieve the desired result." Reference (b), page 149.

14. "All distortion as to course is lost when the design is viewed from above. This was one of the reasons why dazzle camouflage was not applied to the battleships. Its chief value is as a defense against submarine attack where the enemy point of view is low." Reference (b), page 149.

15. "In the first American designs the aim was to give the maximum course distortion possible, and to create the illusion that the vessel was steering as much as 90° off her true course, but the later

tendency was to strive for a more modest distortion, and one which would be effective during a longer period of time. Designs of the first type were apt to be weak when the bessel was seen very nearly bow on, and when seen three or four points off the bow the change in the apparent size of the vessel would in a short time possibly give the lie to the deception caused by the design.

16. "The best designs were those which were capable of a double interpretation, and would leave the observer in doubt as to whether the approaching vessel would pass on his starboard side or would be well over to port.

17. "When the British abandoned the large patterned camouflage altogether and went over to the use of stripes entirely, none of the other countries followed the example. Our first striped design, Type 3, Design C, was produced in April, 1918, and was issued to the Shipping Board on May 13, before the British had gone over to the "zebra" type of design. With many variations we utilized this same stripe motive in a large number of subsequent designs, but it was never deemed advisable to abandon all other types of design in its favor. It is perhaps worthy of note that Lieutenant-Commander Wilkinson particularly commended our Type 3, Design C, and spoke of it as the best of our designs. (William Andrew Mackay's report to the United States Shipping Board. London, November 14, 1918).

18. "We reached conclusions different from the British in regard to the use of verticals in dazzle designs. The fear of vertical lines has been one of the current superstitions prevailing throughout all of the brief history of marine camouflage. In the early stages it was customary to claim that this or that type of design "destroyed vertical lines and thereby rendered range finding more difficult." Design schemes involving the use of vertical lines were instantly rejected by persons who might have been supposed to be in possession of accurate information. And yet all the time camouflage was being considered primarily as an anti-submarine device, and there was no reason to suppose that the Germans had found any way of equipping a periscope with a horizontal-base coincidence range-finder.

19. "At first we followed the conventional British practice in the treatment of corners and wrapped bands of color around them in diagonal fashion. The British at that time, and apparently up to the very last considered it a vital defect for an area of color to be allowed to stop on the vertical line formed by the sharp corner of a cabin, for example. Experiment convinced us, however, that there was no more effective way of concealing the exact position of a corner than by a series of vertical bands and patches of light and dark. There commonly exists a marked difference in the illumination on either side of the corner, and covering the corner with an area of color may diminish this difference but rarely obliterates it entirely. If on the other hand the color stops sharply on the corner the observer is often left in doubt as to whether the sharp line created does indeed indicate a corner or whether it is merely the edge of a vertical band of paint. In our very latest designs the commonest method of treating the superstructure was by a scheme of vertical lines and patches." Reference (b), pages 155 and 156.

20. American designs of 1918. The approved designs produced during 1918 in the subsection of Design of the Camouflage Section of the Bureau of Construction and Repair reached a total of 495 at the close of active work of this nature, and of this number 193 had been made for Navy vessels and 302 for the United States Shipping Board vessels. Reference (b), page 157.

21. In the Naval Torpedo Station at Alexandria, Virginia, are collected a large number of designs. We believe, but do not know with certainty, that these are some or all of the above 495. The designs employ black, gray, gray white, greenish gray, blue and yellow colors. Each design was apparently prepared for a particular ship as designated on the drawing.

22. Five of the designs were selected at random, and were painted on a 14 inch model. They were viewed in the Laboratory theatre; their photographs are shown in Plate 9. In general they produced no marked course distortion but gave the effect of course confusion or uncertainty. They appeared to be very successful designs from this standpoint.

23. We do not know how these designs were arrived at, nor is there any statement in the references to indicate the experimental method used by the subsection of Design in developing and testing the designs. True, an elaborate theatre was built for the purpose of testing the designs on small ship models, as described in reference (c), pages 31 to 60, but we infer that it was never used, for the statement is made, reference (c), page 59, that the equipment had not been entirely perfected when the work was discontinued, although several trial runs had been made.

24. To examine the designs collected at the Naval Torpedo Station, Alexandria, it would be necessary to paint each design on a model of the ship and observe the model in the laboratory theatre. This could not be done in the time available for the present work. Not until it is done, however, can the value of the designs be said to be clearly known.

Chapter 4

NEW COURSE DISTORTION DESIGNS

25. Experimental. It appeared that little could be added to the 1918 patterns with their rather vague and successful characteristic of confusion, although the number of such designs could perhaps be increased almost indefinitely. It seemed, however, that there were possibilities of development of new course distortion designs and the present experiments were instituted to this end. Small models about 14 inches long of various types of ships were procured. These were painted with the designs and viewed in a simple but effective theatre arranged in one of the laboratory rooms. The theatre consisted of a platform to represent the sea on which the model was placed, with a painted sky background. Varied illumination was provided from suitably disposed adjustable lights. Observations were made with various types of small telescopes, one of which was the optical equivalent of a periscope.

26. General principles. Course distortion designs conceivably are of two types which may be described as "obtrusive" designs and "unobtrusive" designs. The obtrusive design endeavors to produce the deception by bold and distinct pattern. Therefore the observer perceives immediately that the ship is painted in an unusual way and may be expected to infer that the painting is for the purpose of delusion. The unobtrusive design aims to produce the deception by a pattern which is not noticeably unusual. In this case, if the design is successful, the observer is deceived as to the course of the camouflaged ship and is ignorant of the fact that he is deceived.

27. No evidence could be discovered that colors added to the effectiveness of the designs, and therefore all the new designs presented here employ only shades of gray, with no colors, some designs using three shades of gray and some two shades of gray. The three shades of gray are shown in Plate 8, the lightest shade being Standard Navy Gray and the darkest shade nearly black. The shades used in the designs of Plates 1 to 7 are evident from an inspection of the Plates. White would be a useful color but is avoided, perhaps unnecessarily, because of the increase in visibility which it might occasion at times.

28. The following general remarks may be made regarding course distortion design:

(a) All course distortion designs depend on painting a pattern of distorted perspective on the sides of the ship.

(b) The distortion of perspective must neither be too slight nor too extreme.

(c) Distortion of perspective such as to make the stern appear nearer and the bow further than is actually the case is more successfully accomplished than the opposite distortion which pushes the stern away and brings the bow nearer. In other words, perspective distortion which twists the course of the ship away from the observer is more effective than distortion which twists the ship toward the observer. This is particularly true for ships with pronounced sheer.

(d) The superstructure may be painted where possible either with bold pattern to give a confusing effect or with a purposefully chosen pattern to supplement the distortion design on the hull.

(e) Course distortion may be achieved by treating only the hull and leaving the superstructure untouched, or by treating only the superstructure and leaving the hull untouched. But when both are treated the combined effect is much more convincing than the sum of the two effects separately.

(f) Although in general any design is applicable to any type of ship, advantage may be taken of structural characteristics to improve the details of the design. Therefore it is best to consider each type of ship separately and to work out the design best suited to the particular type in question.

(g) The effectiveness of painted designs is dependent on the position of the sun and on visibility. For example, against the sun the visible surfaces of a ship are in shadow and camouflage effects are inappreciable.

29. Obtrusive course distortion designs. The designs are shown in Plates 1 to 5. They are all similar in that they twist the ship away from the observer. For example, to an observer looking north, a ship heading in directions south of west appears to be heading west or north of west; and a ship heading in directions south of east appears to be heading east or north of east. In general any of the designs may be used on any type of ship. Both sides of a ship may be painted with the same, or with different, designs.

30. When viewed nearly bow-on, or stern-to, the designs of Plates 1 to 5 produce a confusing effect rather than a definite course distortion effect. In this respect they have the characteristic of the American World War designs of Plate 9. In Plate 10 are shown views nearly bow-on of the designs of Plate 1a and Plate 2a. The confusing effect is due primarily to superstructure painting and to a lesser degree to hull painting.

31. A close view of the bow and superstructure details of the design of Plate 4b is shown in Plate 11. Plate 11a is the uncamouflaged cruiser at an angle of 45°, and Plate 11b the camouflaged cruiser at the same angle. The general purpose of the superstructure camouflage was to produce confusion.

32. An effective course distortion design for the superstructure is given in Plate 12d. The method of obtaining the design consisted in observing the prominent shadows in the superstructure when the ship is heading away from the observer, and painting these shadows on the superstructure when the ship is heading more or less toward the observer. The various steps are illustrated in the pictures of Plate 12a, b and c, which refer to the observer looking north. Plate 12a is the unpainted ship pointing northwest and lighted by a western sun to give shadows. Plate 12b is the unpainted ship pointing southwest. Plate 12c is the camouflaged ship pointing southwest. Plate 12d is a broadside view of Plate 12c. In the case of a real ship underway at sea the false painted rudder, seen clearly in Plate 12d, may rarely be visible and therefore of no importance; it is, however, an innocuous detail.

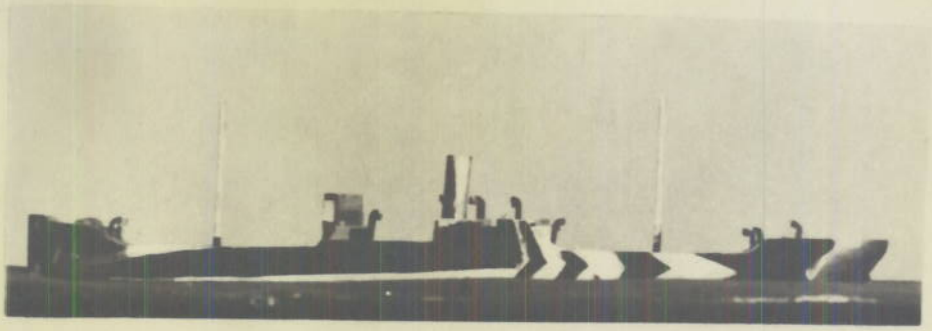
33. The design of Plate 12 is open to an interesting criticism. Suppose that the situation of Plate 12c occurred, that is, that the observer was looking north at the ship actually heading southwest. Due to the painted shadows, however, he would be deceived into thinking that the ship

was heading roughly northwest. Assume now that the sun was in the east; the ship would be well illuminated to produce the desired deception. A moment's reflection on the part of the observer would convince him, however, that an easterly sun could not possibly produce such shadows on a ship which he supposed was moving in a northwesterly direction. He would argue that he should see no shadows at all. He would therefore conclude that the shadows must be fictitious, that the ship was camouflaged and that his impression of a northwest course of the ship was erroneous. Whether the usual observer is a keen enough optician to follow through the foregoing train of thought and to extricate himself from the trap can not be said.

34. The superstructure design of Plate 12 may be used in whole or in part with any of the hull designs of Plates 1 to 5 which are of such a nature that they do not interfere with the superstructure design. In fact it is used on the designs of Plate 1b and Plate 2b. The design of Plate 12 consisted of dark painting on a light background. The converse design of light painting on a dark background is equally effective; such a design is shown in the pictures of Plate 13a and b, which again refer to the observer looking north. The superstructure design of Plate 12 is most effective on types of ships with prominent and simple superstructure. It was less successful on a model of a destroyer, because the destroyer superstructure had no large unencumbered areas of shadow. The various steps in putting the design on the destroyer model are illustrated in Plate 14.

35. An illustration of an unsuccessful course distortion design is given in Plate 13c. The bow design is too extreme and too complex; it is inconsistent with the stern design. When the model was heading toward the observer the design produced confusion and from this standpoint was successful.

36. Unobtrusive course distortion designs. The designs are shown in Plates 6 and 7. Just as in the case of the obtrusive designs, the unobtrusive designs are all similar in that they twist the ship away from the observer. The aim has been to originate designs of such a nature and boldness as to produce course deception and yet not so bold that the observer realizes their presence. Thus due to its essential inconspicuousness such a design can not be effective for as long a space of time or under as wide a variety of conditions of lighting, range and visibility as a bolder design. This consideration may reduce the value of an unobtrusive design to the vanishing point. The choice between an "obtrusive" and an "unobtrusive" design, which are relative terms, is the choice between a design which may be moderately effective over a wide range of conditions and a design which may be exceedingly effective over a very narrow range of conditions. The choice can be decided by experiments with ships at sea and not with models in a laboratory.



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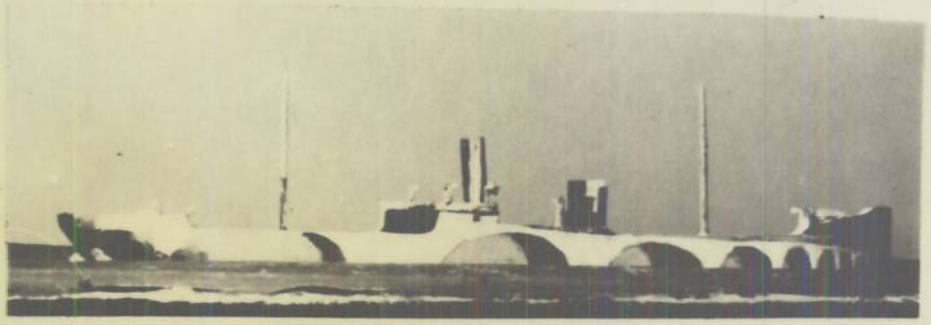

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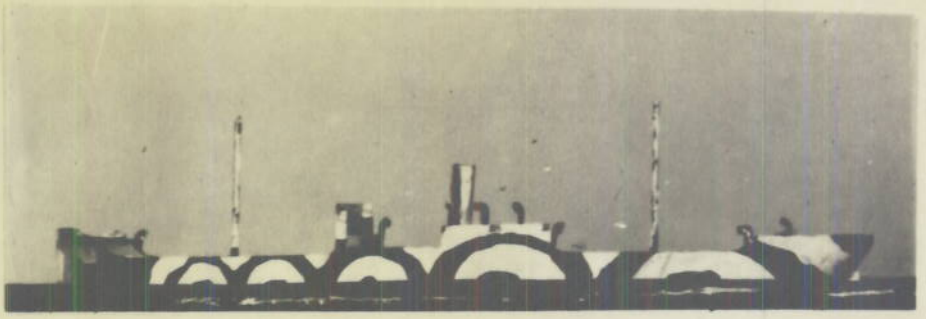

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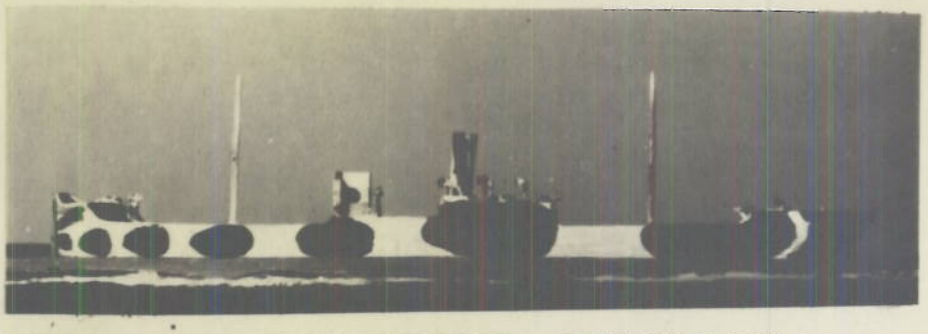
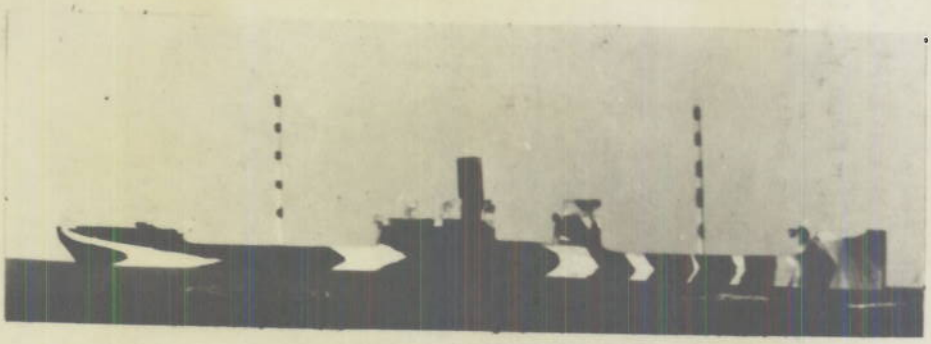


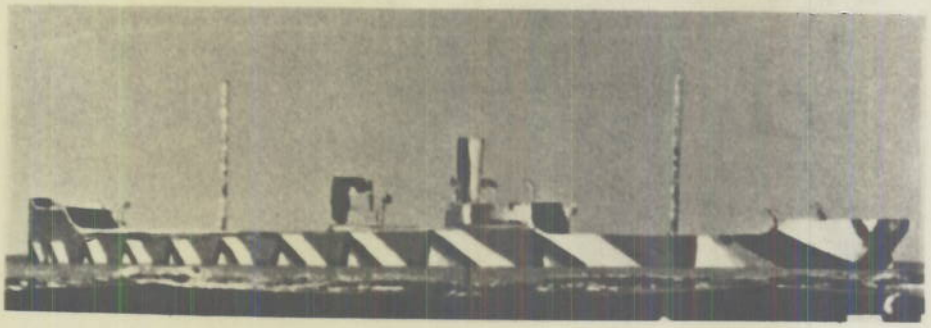
d

OBTRUSIVE COURSE DISTORTION DESIGNS. MERCHANT VESSEL.
BROADSIDE VIEWS.

PLATE 1



a



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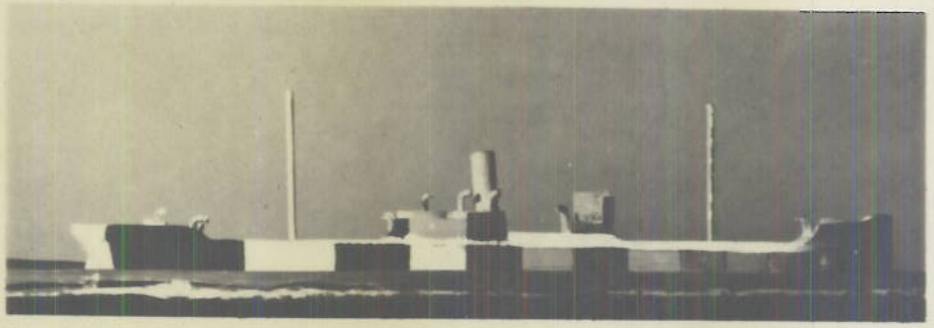

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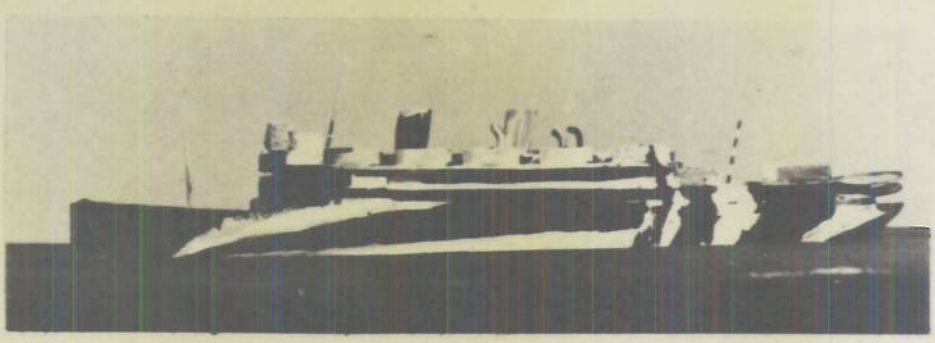
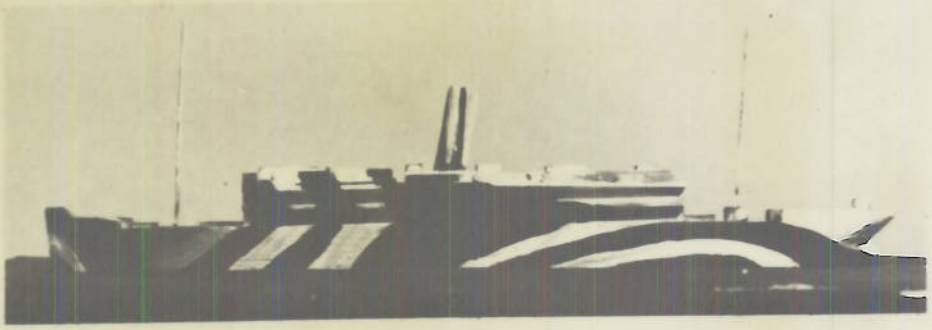
OBTRUSIVE COURSE DISTORTION DESIGNS. MERCHANT VESSEL.
BROADSIDE VIEWS.

PLATE 2



a

b



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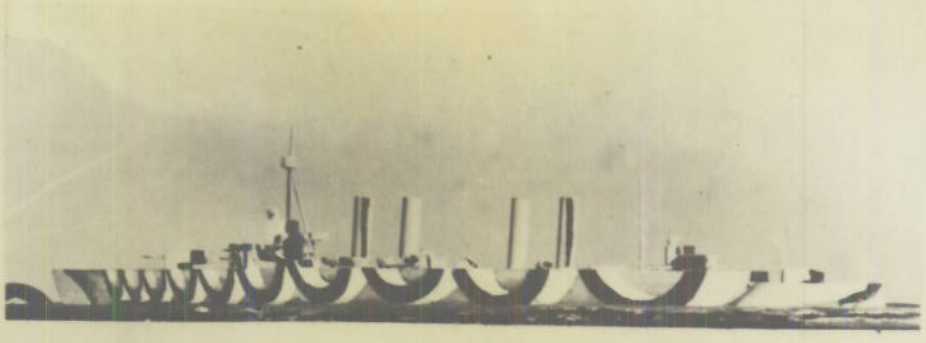
OBTRUSIVE COURSE DISTORTION DESIGNS. PASSENGER VESSELS.
BROADSIDE VIEWS.

PLATE 3



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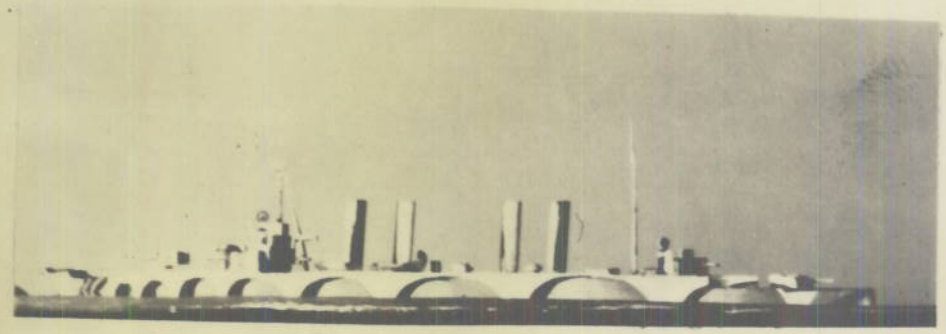

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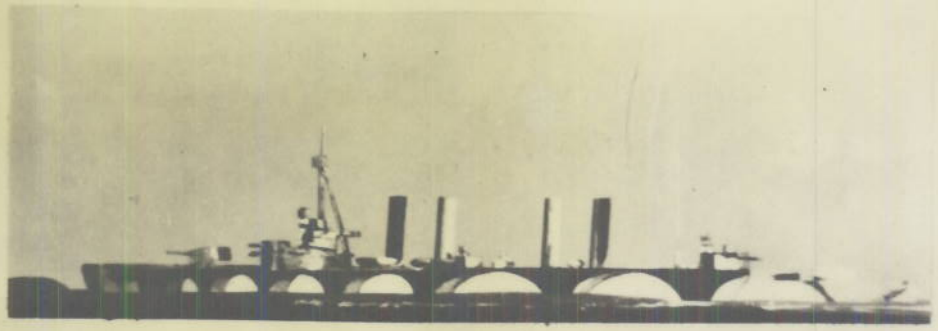

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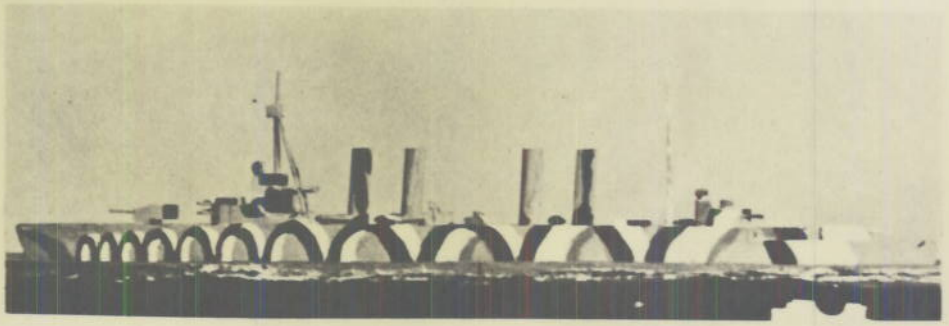

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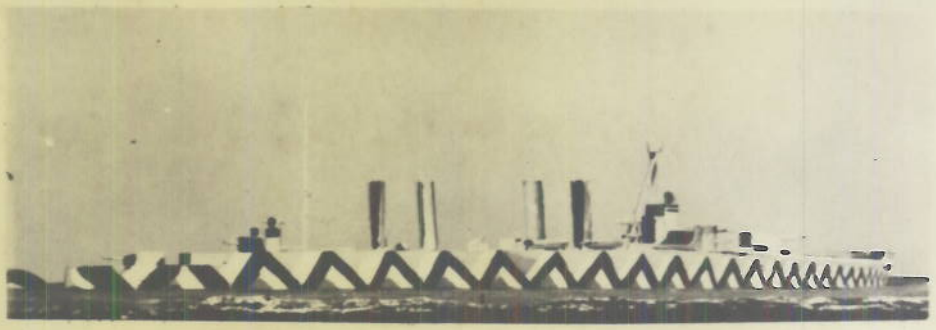
OBTRUSIVE COURSE DISTORTION DESIGNS. CRUISER. BROADSIDE VIEWS.

PLATE 4

a



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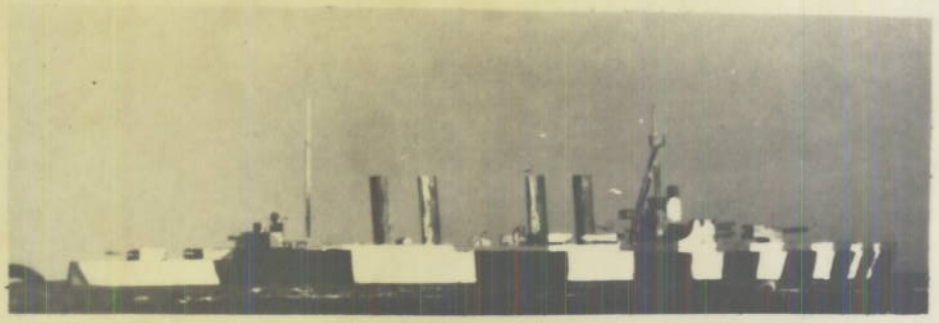
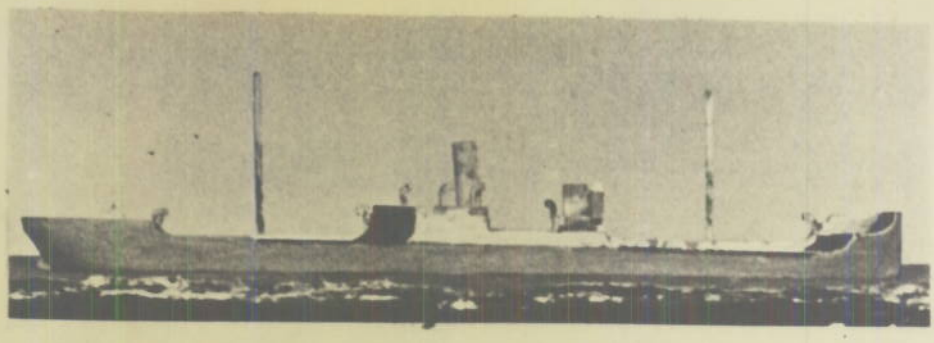


c

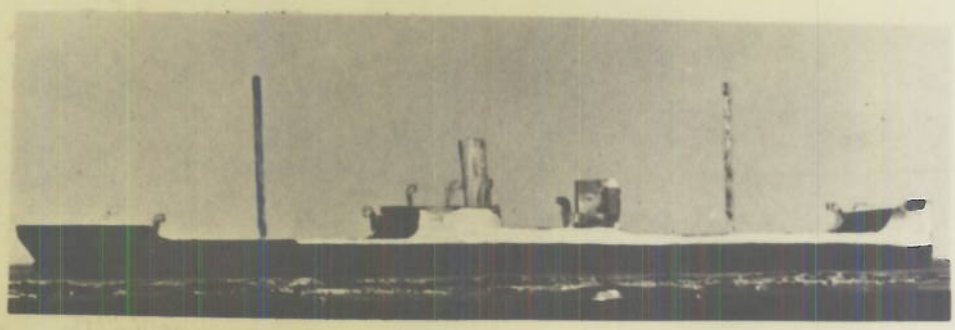
d

OBTRUSIVE COURSE DISTORTION DESIGNS. a ,b , c, CRUISER;
d, DESTROYER. BROADSIDE VIEWS.

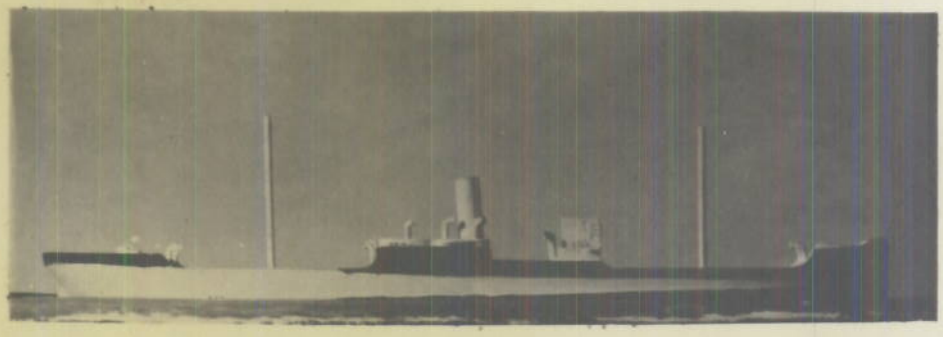
PLATE 5



a



b

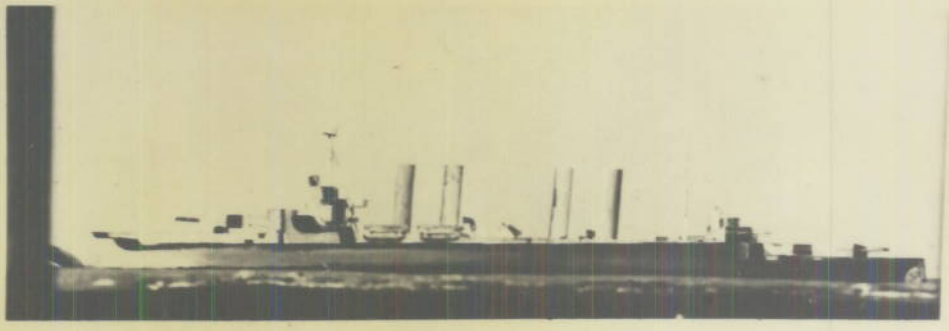


c

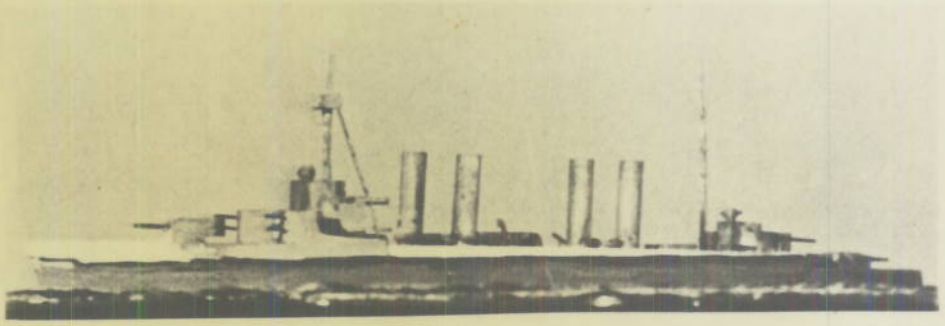
d

UNOBTRUSIVE COURSE DISTORTION DESIGNS. MERCHANT VESSEL. BROADSIDE VIEWS.

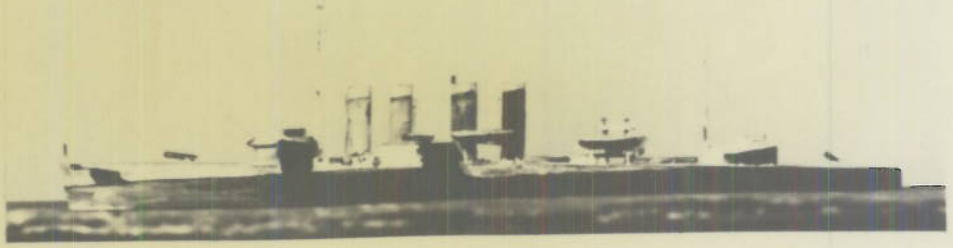
PLATE 6



a



b

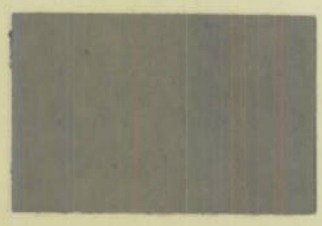


c

UNOBTRUSIVE COURSE DISTORTION DESIGNS. a , b , CRUISER;
c, DESTROYER. BROADSIDE VIEWS.

PLATE 7

a

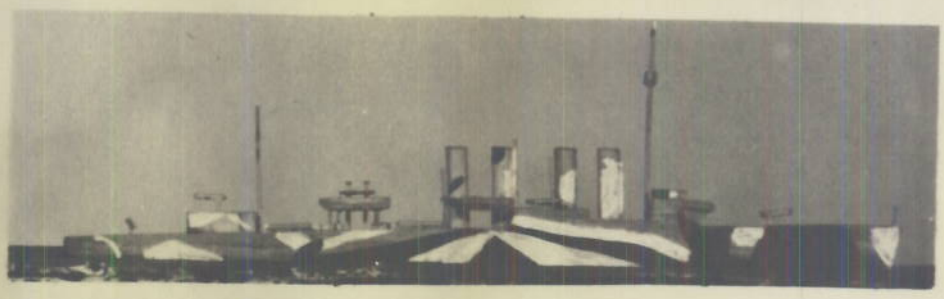


b

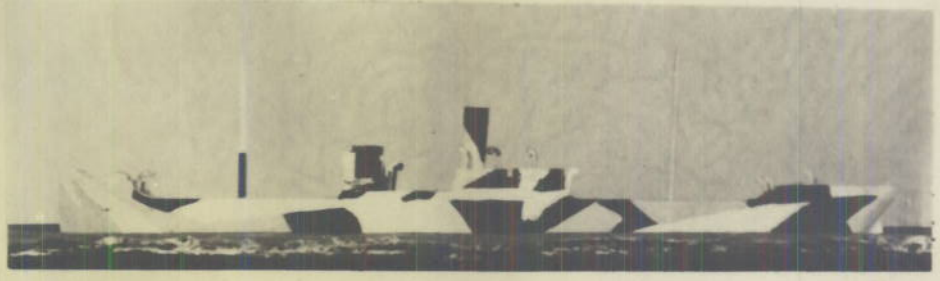
c

COLORS USED IN CAMOUFLAGE DESIGNS

PLATE 8

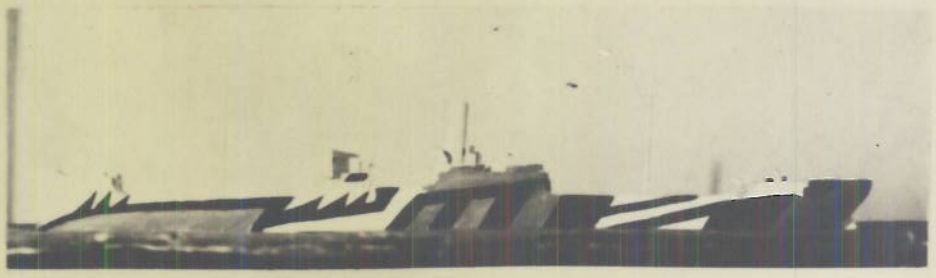


a



b

c

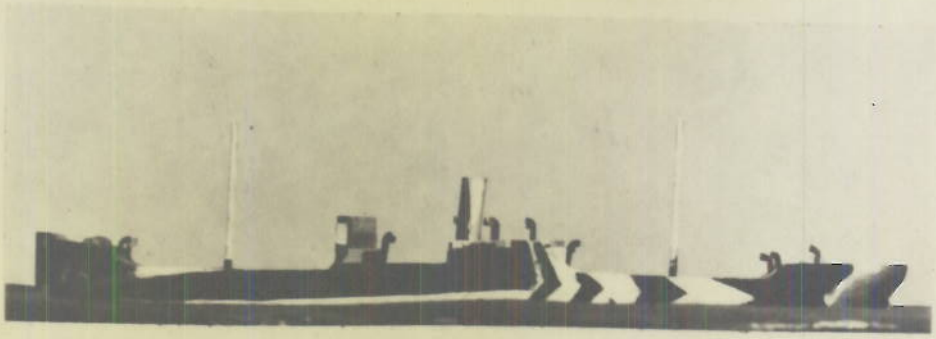


d

e

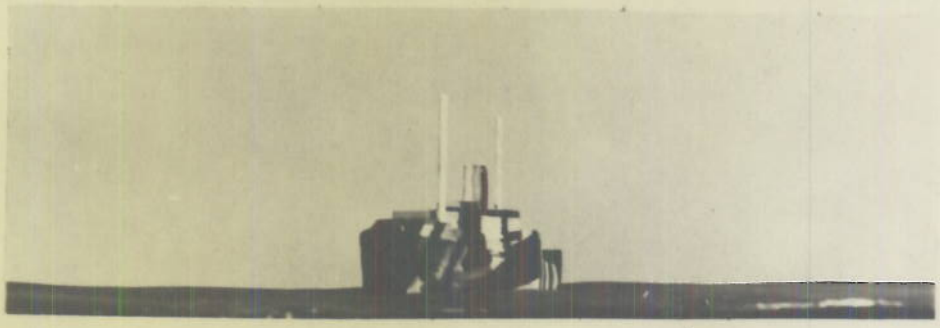
AMERICAN WORLD WAR CAMOUFLAGE DESIGNS. BROADSIDE VIEWS.

PLATE 9



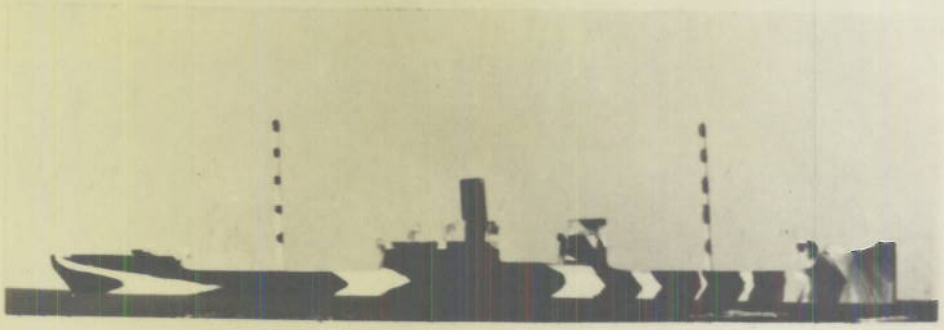
a

DESIGN OF PLATE 1a, BROADSIDE VIEW.



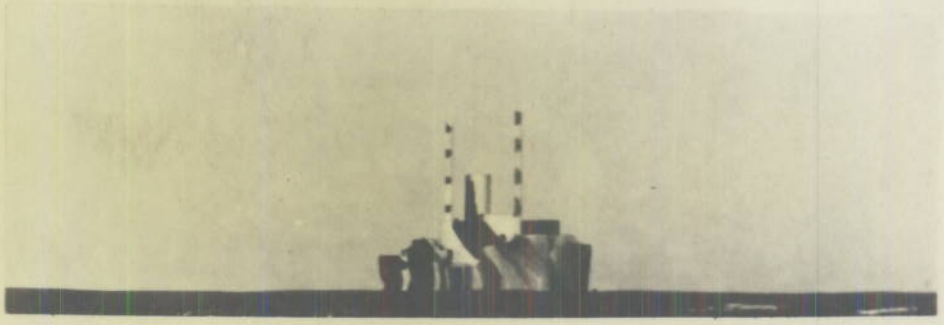
b

DESIGN OF PLATE 1a, VIEW NEARLY BOW-ON.



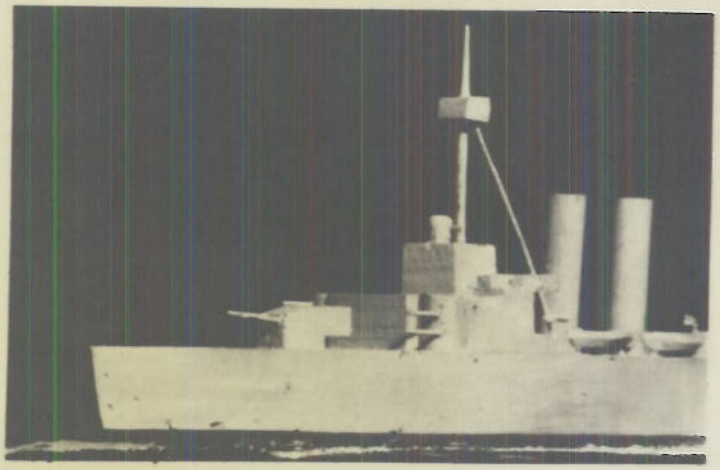
c

DESIGN OF PLATE 2a, BROADSIDE VIEW.



d

DESIGN OF PLATE 2a, VIEW NEARLY BOW-ON.



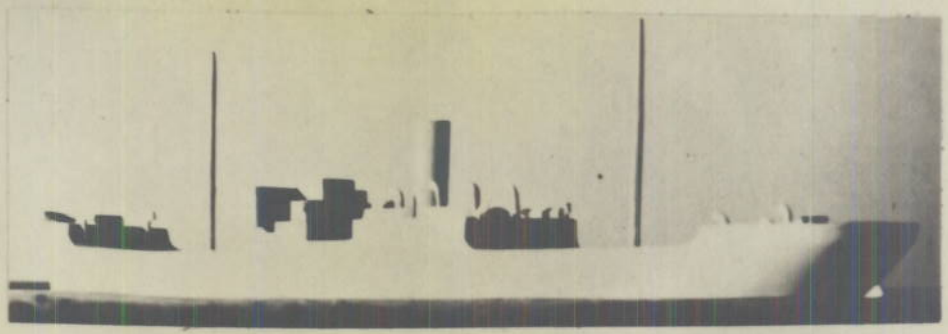
a

UNCAMOUFLAGED

b

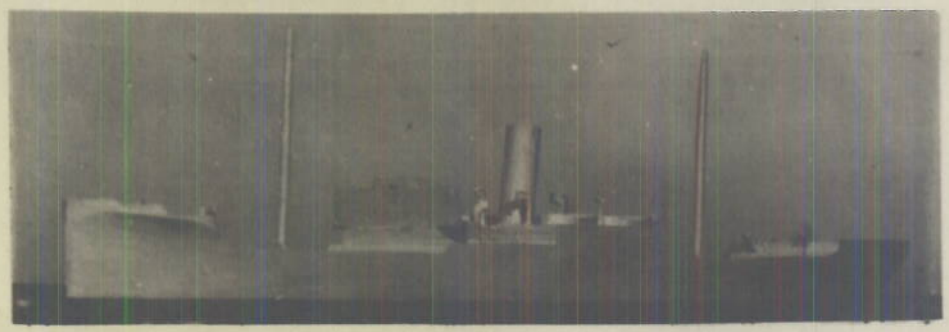
CAMOUFLAGED, DESIGN OF PLATE 4b.

DETAILS OF BOW OF DESIGN OF PLATE 4b.



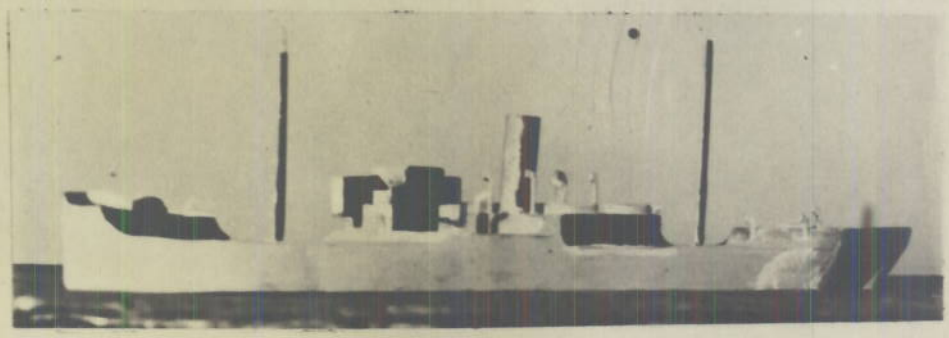
a

POINTING NORTHWEST, UNPAINTED, LIGHTED TO GIVE SHADOWS.



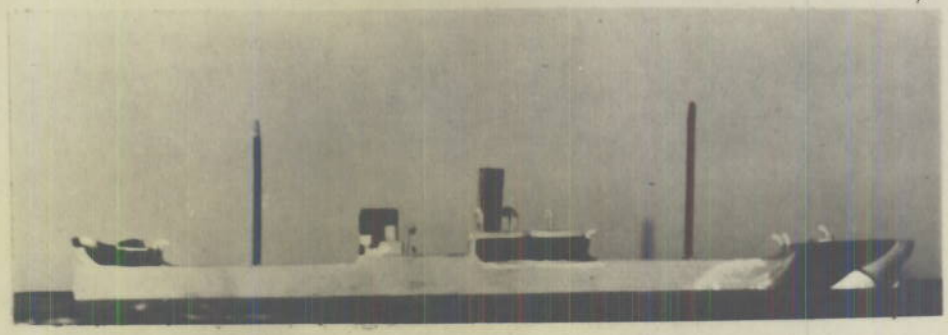
b

POINTING SOUTHWEST, UNPAINTED.



c

POINTING SOUTHWEST, PAINTED SHADOWS.

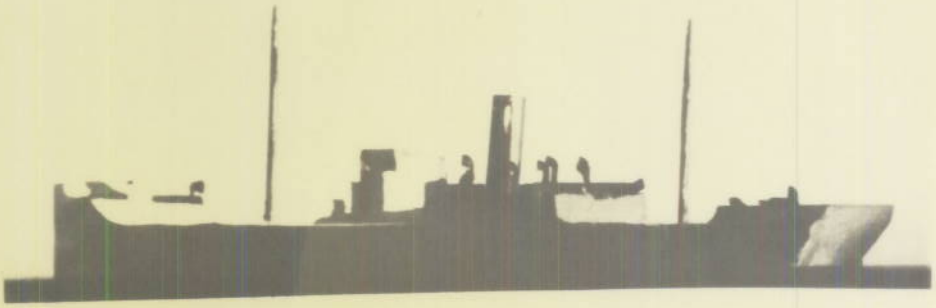


d

BROADSIDE VIEW OF PAINTING.

PLATE 12

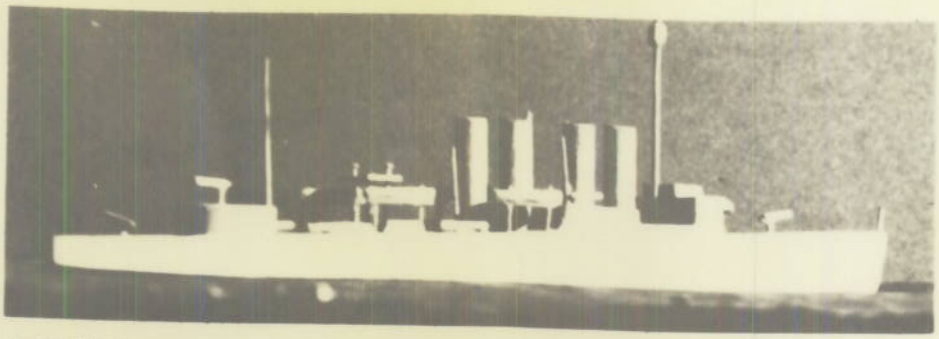
BROADSIDE VIEW, POINTING WEST.



POINTING SOUTH-EAST.

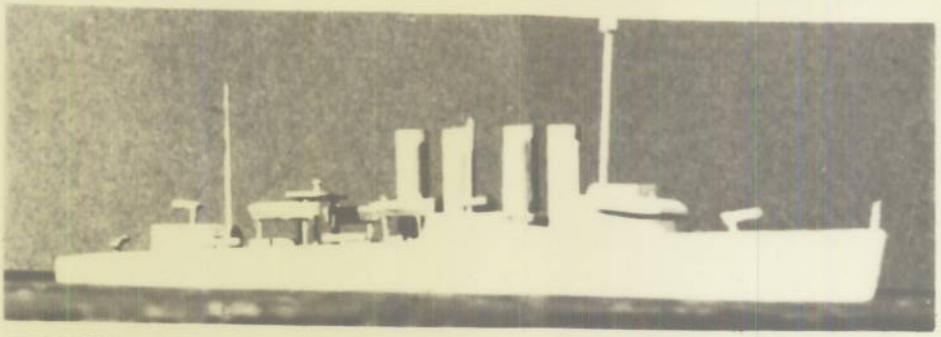
UNSUCCESSFUL COURSE DISTORTION DESIGN.

PLATE 13



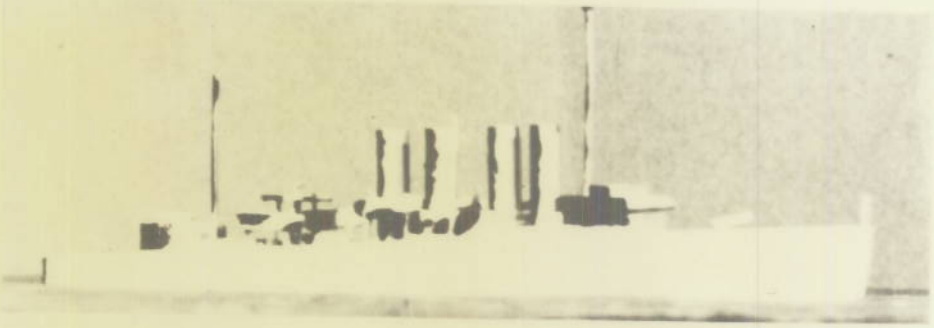
a

POINTING NORTHEAST, UNPAINTED, LIGHTED TO GIVE SHADOWS.



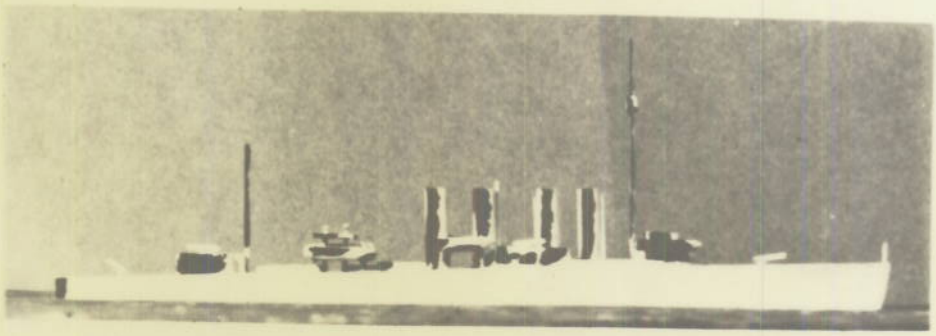
b

POINTING SOUTHEAST, UNPAINTED.



c

POINTING SOUTHEAST, PAINTED SHADOWS.



d

BROADSIDE VIEW OF PAINTING.

PLATE 14