RESTRICTED

FM 30-21

WAR DEPARTMENT

BASIC FIELD MANUAL

MILITARY INTELLIGENCE
ROLE OF AERIAL PHOTOGRAPHY

RESTRICTED

BASIC FIELD MANUAL

MILITARY INTELLIGENCE

ROLE OF AERIAL PHOTOGRAPHY

CHANGES
No. 1

WAR DEPARTMENT,
WASHINGTON, May 27, 1942.

FM 30–21, November 1, 1940, is changed as follows:

■ 16. TITLING OF NEGATIVES.

* * * * * * *

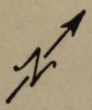
c. Method.

* * * * * * *

(4) Scale of photograph expressed as a representative fraction or as altitude above ground in feet and focal length of camera.

* * * * * * *

(8) Serial number of negative. In addition to a north point, the following is the legend on a vertical:



Saranac, N. Y.—(321–437)—1: 20,000—(2:00 P. M.)—(24–Aug–40)—97th—M5.

The information given above may also appear in different sequence, giving approximately the same information.

* * * * * * *

[A. G. 062.11 (3–27–42).] (C 1, *May 27, 1942.*)

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:

J. A. ULIO,
Major General,
The Adjutant General.

U. S. GOVERNMENT PRINTING OFFICE: 1942

RESTRICTED

BASIC FIELD MANUAL

MILITARY INTELLIGENCE

ROLE OF AERIAL PHOTOGRAPHY

CHANGES No. 2

WAR DEPARTMENT,
WASHINGTON, December 28, 1942.

FM 30–21, November 1, 1940, is changed as follows:

SECTION VII (ADDED)

GRAPHICAL REPRESENTATION OF INFORMATION

■ 57. RECORDING CHANGE.—*a.* In the G–2 section of any unit, information on enemy activity is obtained by a number of different types of studies. A means of recording changes should be used which fits both the situation and the purpose for which the information is obtained.

b. In forward positions, changes in such activities as entrenchments, obstacles, antitank fortifications, barbed wire, communications, supply installations, and dummy positions must be recorded. The most common means of recording such information is by conventional signs and symbols on maps or overlays. However, in the case of installations far to the rear or in the event of stabilization in a forward area, there are certain types of information which may best be recorded graphically.

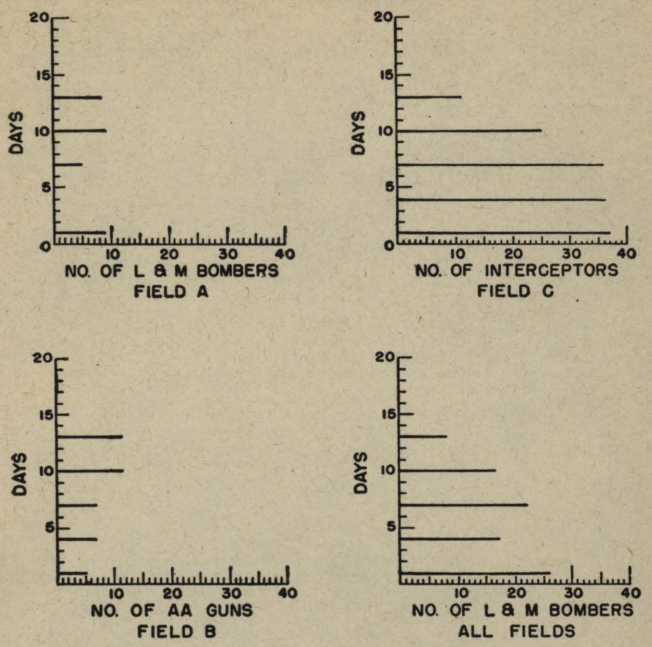
■ 58. GRAPHICAL REPRESENTATION.—Quantitative changes in enemy installations which occur over a period of time are best recorded graphically. Examples of such installations are dumps, camps, and landing fields. Graphic representation gives the degree of use of such installations, whereas indicating them on a map merely shows their presence.

■ 59. EXAMPLE.—The following is an example of the use of graphic representation: In a given theater three advance landing fields have been located and all have been photographed from 25,000 feet. The intelligence mission requires photographing

499962°—42

those fields every 3 days in order to determine enemy activity there. At the end of 13 days the following information is available from interpretation of the aerial photographs:

	Planes present			Dumps	Anti-aircraft		Vehicles	Buildings		Tents
RECORD—FIELD A										
Day	L. & M. bombers	Interceptors	Others	Present	Guns	Machine guns	Present	Under construction	Present	Present
1st	9	10	2	2	12	15	15	0	0	2
4th	0	0	2	2	12	15	12	0	0	2
7th	6	0	2	2	12	15	8	0	0	2
10th	9	10	1	2	12	15	13	0	0	2
13th	9	8	1	2	12	15	12	0	0	0
RECORD—FIELD B										
1st	0	0	1	1	4	12	3	0	1	6
4th	0	3	0	1	8	12	8	0	1	6
7th	0	9	1	1	8	12	5	0	1	6
10th	0	9	3	2	12	24	23	4	1	18
13th	0	8	2	2	12	24	17	4	1	18
RECORD—FIELD C										
1st	18	36	5	5	20	30	23	0	8	3
4th	18	35	5	5	20	30	27	0	8	0
7th	18	35	3	5	20	30	19	0	8	0
10th	9	24	0	5	12	24	14	0	7	0
13th	0	10	0	5	12	24	11	0	4	0
RECORD—ALL FIELDS										
1st	27	46	8	8	36	57	41	0	9	11
4th	18	38	7	8	40	57	47	0	9	8
7th	24	44	6	8	40	57	32	0	9	8
10th	18	43	4	9	36	63	50	4	8	20
13th	9	26	3	9	36	63	40	4	5	18



The line graphs shown above give one method of plotting graphically the information in the preceding table. Anyone interested in any particular installation or operation can tell at a glance by the length of the horizontal lines what change or progress is taking place.

[A. G. 062.11 (10–22–42).] (C 2, Dec. 28, 1942.)

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:

J. A. ULIO,
Major General,
The Adjutant General.

U. S. GOVERNMENT PRINTING OFFICE: 1942

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FM 30–21

BASIC FIELD MANUAL

MILITARY INTELLIGENCE
ROLE OF AERIAL PHOTOGRAPHY

Prepared under direction of the Chief of Staff

UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON : 1940

WAR DEPARTMENT,
WASHINGTON, *November 1, 1940.*

FM 30–21, Military Intelligence, Role of Aerial Photography, is published for the information and guidance of all concerned.

[A. G. 062.11 (7–30–40).]

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:

E. S. ADAMS,
Major General,
The Adjutant General.

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BASIC FIELD MANUAL

MILITARY INTELLIGENCE

ROLE OF AERIAL PHOTOGRAPHY

(The matter contained herein supersedes TR 210–10, January 4, 1926.)

SECTION I

GENERAL

■ 1. PURPOSE.—The purpose of this manual is to prescribe the procedure for the coordination of aerial photography, to furnish a guide for the determination and interpretation of military information shown on aerial photographs, and to serve as a reference in the training of personnel in the tactical study of aerial photographs.

■ 2. SCOPE.—In addition to providing the necessary coordination between ground and air troops in the production and utilization of aerial photographs, this manual covers the fundamentals of tactical interpretation of aerial photographs to the extent needed by military intelligence personnel. The manual does not duplicate the information contained in FM 21–25 and FM 21–26 (now published as TM 2180–5). Those manuals cover the more detailed instruction needed by all map users, while this manual is confined to the coordination and tactical aspects only.

■ 3. IMPORTANCE OF PHOTOGRAPHS.—Aerial photographs are one of the most important sources of information available to a commander as well as to all echelons of command. As a source of combat intelligence they are of paramount importance to all intelligence sections, for when successfully interpreted they frequently reveal the most carefully guarded secrets in hostile territory. When properly titled, they are a

type of map showing innumerable details and later information not shown on the best topographic maps. When examined stereoscopically, they are of the greatest importance in studying the terrain. In the field of counterintelligence, they are important as a check upon the use of natural and artificial concealment and of camouflage discipline.

■ 4. VERTICAL AERIAL PHOTOGRAPHS.—*a. General.*—A vertical aerial photograph is one which is taken when the lens axis of the camera is approximately perpendicular to the earth's surface. Such photographs are very useful in making terrain studies and in gaining information of enemy activity, in the preparation and revision of maps, and, when suitably marked, as map substitutes.

b. Pinpoints.—Two or more stereoscopic vertical photographs of an isolated object or spot constitute a pinpoint. Airdromes, supply depots, dumps, road crossings, bridges, or other bottlenecks on lines of communication requiring detailed study are suitable objects for pinpoint photography. (Fig. 1.)

c. Mosaics.—An aerial mosaic is an assembly of two or more overlapping vertical photographs as described in FM 30–20. The mosaic is the most common form of photomap which will be encountered. In intelligence studies, the mosaic is especially useful in studying features that cannot be followed out completely on one photograph, such as paths, roads, railroads, etc. The principal purpose is to show an entire area in one photograph for use as a check upon new information, and to assist examining officers in comparing data on photographs with data shown on existing maps.

d. Stereo-pairs.—(1) *General.*—For details concerning stereoscopic photography and stereoscopic examination of aerial photographs see FM 21–26 (now published as TM 2180–5).

(2) *Use.*—As it is customary to make vertical aerial photographs, with an overlap, stereoscopic examination of any photographed area is possible. This should be the normal procedure in studying aerial photographs for military information. In addition to furnishing valuable information concerning the topography of a given area, stereo-pairs supply

still more valuable information concerning enemy activities. They are useful in overcoming the effect of camouflage and in locating various installations. They facilitate the detection of numerous details which could not otherwise be recognized on the ground. A stereoscopic examination makes it possible to determine in advance the effect of the terrain upon the location of defensive positions and of covered routes thereto, upon lines of supply and evacuation, upon tanks, upon observation and command posts, and upon axes of signal communication.

e. Scale.—(1) *General.*—Vertical photographs for intelligence purposes should be made of small, medium, or large scale, depending upon the purpose for which required.

(2) *Small.*—Small scale aerial photographs (1:15,000 or smaller) cover a large area but show comparatively little detail. They are of value, for they furnish considerable information concerning camps, dumps, railway activity, large demolitions such as the destruction of bridge spans 150 feet or more in length, and heavy mine craters, trench systems in open terrain, new road and rail construction, and large bodies of troops except in wooded or brush-covered country. They are also used in the preparation and revision of maps. (Figs. 12 and 50.)

(3) *Medium.*—Medium scale aerial photographs (1:10,000 to 1:15,000) show sufficient detail for ordinary intelligence and counterbattery purposes. Partly organized trench systems, airplanes on the ground, outlines of airdromes and airfields, railroad trains, columns in close formation on roads, partly concealed dumps and depots, areas upon which heavy artillery concentrations have been placed, battery positions, detail of trenches, and other field works may be seen. (Fig. 28.)

(4) *Large.*—Large scale aerial photographs (1:5,000 to 1:10,000) show great detail and are of use in distinguishing between genuine and dummy gun positions, in locating camouflage work, tank mine fields, railway cars, motorized and horse-drawn vehicles, shell holes and exploded tank mines, observation and command posts, machine gun emplacements, road barriers, demolitions of small bridges and culverts, indications of troop concentrations, such as tracks, paths,

poorly concealed equipment, pole lines carrying telegraph and telephone circuits, open wire and cable lines, bands of wire entanglements, and many other details. Large scale photographs should be limited to pinpoints. (Figs. 1 and 17.)

■ 5. OBLIQUE AERIAL PHOTOGRAPHS.—*a. General.*—Any aerial photograph which is not a true vertical is an oblique. In an oblique photograph the perspective is somewhat distorted due to the inclination of the lens, and the scale varies rapidly from the foreground to the rear. Information obtained from such photographs should always be carefully checked against a vertical photograph or map or both; otherwise the distorted perspective may cause serious errors in the location of points.

b. High oblique photographs.—A high oblique photograph is an oblique which shows the terrain up to the line of the horizon. It is very useful to the command, showing clearly the general form of the terrain and the succession of enemy organizations just as one would see them from a very high point of observation. (Fig. 2.)

c. Low oblique photographs.—Low oblique photographs, particularly those taken close to the ground, cover less terrain than high obliques but give more detail. They facilitate a correct understanding of relief, make slopes and sunken roads stand out, and reveal the breaks and gaps not visible on single vertical photographs. (Fig. 3.)

■ 6. NIGHT PHOTOGRAPHS.—Under favorable conditions, vertical photographs can be taken at night with the aid of auxiliary lighting equipment at elevations up to about 8,000 feet above the ground. Because of the fleeting nature of the light, night photographs are usually limited to single exposures, although small strip mosaics can be made. There is little difference between the detail shown on night and daylight photographs, but because the former must be taken at a comparatively low altitude one exposure necessarily covers a smaller area. (Fig. 4.)

■ 7. INFRARED PHOTOGRAPHY.—Infrared photography is taken on a special film which, while it is somewhat sensitive to most colors, is especially sensitive to infrared light. On this film,

objects register in black, white, or gray, primarily according to the amount of infrared light they reflect. Thus the relative shades of gray in which objects register on infrared film differ from the relative shades of gray in which they register on panchromatic film.

■ 8. COLOR PHOTOGRAPHY.—Color transparencies render colors in approximately their true values from altitudes of about 5,000 feet. At very low altitudes, color film requires such long exposure that motion is apparent. At altitudes in the vicinity of 10,000 feet and higher, color pictures are far too blue to be of great value. Color transparencies, except Dufay color transparencies, are slow and difficult to make and reproduce. However, because they give a grainless, easily interpreted picture and under suitable conditions render colors about as seen by the human eye, they will be used in war. Increased use may be expected as color photography is improved.

■ 9. QUICK WORK PHOTOGRAPHY.—Aerial photographs can be produced in whole or in part in the airplane by the quick work process and delivered direct to appropriate headquarters. In this type of photography no negatives are prepared, the image being recorded directly on the print itself. Normally, the photographic quality of the print will not be equal to that of a print processed in the usual manner. Neither can reproductions be made without rephotographing the picture. Quick work photography will have its greatest application during the actual progress of maneuver warfare, when time does not permit the orderly processing of films and the printing and distribution of the prints. This process makes possible the delivery of photographic information to the intelligence officer a matter of minutes only.

■ 10. SPECIALIST EXAMINERS OF AERIAL PHOTOGRAPHS.—*a.* In divisions and higher echelons of command, the intelligence section may include one or more specialists in the examination of aerial photographs. These specialists should have a thorough knowledge of the organization, marching and bivouacking characteristics, transportation, methods of combat, field fortifications, supply system, disposition of aviation units

on the ground, camouflage, and intelligence procedure of our own Army. In addition, they should have a thorough knowledge of the same things in the enemy's army. They should be patient and persevering and possess keen, observant, analytical minds.

b. The examiner should have, in proper working order, all necessary equipment and material for his work. Among essential items in all echelons should be included the enemy's or our own field fortification and camouflage regulations, maps and aerial photographs of the area, drafting equipment, stereoscope, mimeoscope, rubber cement, and files. The lower echelons will have only simple equipment.

c. The examiners should collaborate closely with intelligence personnel charged with the examination of prisoners, repatriates, and captured documents; with terrestrial and aerial observation agencies; and with sound and flash ranging troops. In this way it will frequently be possible to clarify doubtful items. As assistant intelligence officers, these specialists should be familiar with the intelligence plan and the essential elements of information of the unit to which they pertain. In the course of operations they should be kept fully informed concerning the enemy's organization, plans, activities, fortifications, and movements.

d. During the progress of operations, the specialist examiner should make a detailed study of terrain, objects, and defenses captured from the enemy. If practicable, he should be accompanied by a Signal Corps photographer for the purpose of securing close-up ground photographs of items shown on aerial photographs. In this way he perfects his knowledge of the enemy and completes a working album to assist him in his future work. Whenever possible, he should also study the appearance of identified enemy objects and works from the air.

■ 11. REFERENCES.—Field Manuals pertaining to aerial photography, mapping, and camouflage are listed in the Appendix.

SECTION II

COORDINATION OF AERIAL PHOTOGRAPHY

■ 12. RESPONSIBILITY.—*a.* The *commanding officer* of an organization to which Air Corps units are assigned or attached is responsible for the coordination of photographic missions within his own and subordinate units. He is also responsible for policies relative to the distribution of aerial photographs to all subordinate echelons within the command. In the performance of these duties he is assisted by his assistant chief of staff, G–2.

b. The assistant chief of staff, G–2 of the organization to which photographic aviation is assigned or attached, acting under the authority of the commanding officer thereof, is directly responsible for the coordination between Air Corps units and available topographic engineers, and, with due regard to the essential elements of information announced by the commander, for the coordination of photographic missions of the aviation of his own and subordinate echelons. He is also responsible for the coordination of aerial photography with the other collecting agencies and for making the necessary aerial photographs available to them.

■ 13. PHOTOGRAPHIC RECONNAISSANCE.—*a.* Aerial photographs may be made by aviation units while engaged on combat or reconnaissance missions without specific instructions from higher headquarters. Such photographs are frequently of great importance in making studies of certain activities or terrain features.

b. Photographic reconnaissance missions may be directed by higher headquarters. As far as practicable, such missions must be executed as prescribed in order that the results expected may be obtained.

c. Photography as a means of securing military information has certain definite advantages and disadvantages as compared with visual reconnaissance. It furnishes an exact and convenient document for study and a detailed, accurate, and complete record, since nothing escapes the lens of the camera. However, it is quite sensitive to atmospheric conditions and enemy antiaircraft activities, and the resulting information is delayed in reaching the user by the technical

processes incident to developing and titling the negative and making and delivering the prints. Before making requests for photographs, all responsible officers should take these considerations into account.

d. For the successful accomplishment of aerial photographic missions, it is imperative that all training emphasize the necessity for speed during the several steps in processing while maintaining a high technical quality in the finished product. The necessity of reducing to the minimum the time between exposure of the negative and the delivery of the print must be appreciated by all observation personnel.

■ 14. PHOTOGRAPHIC CAPABILITIES OF AVIATION UNITS.—*a.* The GHQ reconnaissance squadrons and army and corps observation squadrons are provided with trailer laboratory facilities. Working at maximum speed under favorable conditions, a trained photographic section is capable of the following photographic production:

Photographs	Time requisite to produce		Remarks
	From trailer laboratory	From trailer laboratory and other facilities	
Negatives	*Hours*	*Hours*	
15 (5 prints each)	2	1½	Prints partially dried; titled but not interpreted.
50 (5 prints each)	4	3	Do.
100 (5 prints each)	5	4	Do.
Prints			
1,500–2,000	24		Do.
3,000–5,000		24	Do.

b. All agencies making requests for photographs should understand these capabilities.

■ 15. REQUESTS FOR AERIAL PHOTOGRAPHS.—*a.* Requests for aerial photographs will be made through normal channels to the commander of a unit to which observation aviation is attached or assigned. They may be made in writing or

orally, but in any case must contain the following essential information:

(1) Map area or point to be photographed.

(2) Approximate hour of exposure.

(3) For oblique photograph, direction from which to be taken and elevation.

(4) For vertical photograph, the scale expressed as R. F.

(5) Purpose for which the photograph is desired.

(6) Number of prints desired and time and place of delivery.

b. Acting under the authority of the commander thereof, the assistant chief of staff, G–2, of a unit will coordinate all requests for aerial photographic missions and assign a priority to each, taking into account the essential elements of information and the needs of other sections of the general staff and of subordinate units. Requests which remain unexecuted at the end of the day will be considered in connection with later requests and assigned a new priority in conformity with their urgency.

■ 16. TITLING OF NEGATIVES.—*a. General.*—The titling of negatives is the responsibility of the Air Corps. The method employed must be uniform and must include data necessary for ready identification of the area represented, both on the map and on the ground. All prints should be made from the full negative without masks, so that every portion of the negative, including title, will show on the print.

b. Grid systems.—(1) AR 300–15 prescribes various types of grid systems applicable to military maps. All personnel concerned with the production and use of aerial photographs should be familiar with the various systems.

(2) The coordinates of the center of photographs will be indicated (*c* below). If the military grid appears on any of the maps existing for the theater, it will be used in expressing these coordinates. If the military grid is not available, the atlas grid shown on the largest scale map issued to the troops will then be substituted. If neither the military nor the atlas grid is available, a geographic grid will be improvised. For example, a point at 117°40′30″ west longitude; 50°38′00″ north latitude, should be expressed by coordinates

as: 11740W5038N, the nearest minute only being used to express the coordinates.

c. Method.—The titling of aerial photographs made for intelligence purposes in the theater of operations and in all tactical exercises will be in letters and numerals ⅛ inch in height along the black strip at the bottom, reading from left to right, as follows (figs. 6 and 7):

(1) An arrow ½ inch in length in lower left-hand corner of the negative indicating north, with letter N superimposed over center of the shaft.

(2) Name of locality or nearest locality.

(3) Approximate coordinates of the center of the photograph.

(4) Scale of the photograph expressed as representative fraction, in case of a vertical; altitude above the ground in feet and focal length of camera, in case of an oblique.

(5) Hour.

(6) Date arranged in the following order: day, in figures; month, in letters; and year, in figures.

(7) Designation of squadron.

(8) Serial number of the negative.

d. Reconnaissance strips.—The first photographs of a reconnaissance strip will be titled as prescribed in *c* above. The other photographs of the strip will only be numbered serially.

■ 17. EXECUTION OF PHOTOGRAPHIC MISSIONS.—*a. General.*—The commander of a designated observation squadron executes photographic missions in accordance with the priority and conditions specified on the approved request of the headquarters to which assigned or attached.

b. Preparation of photographs.—Upon the successful completion of a photographic mission, the negatives are developed and titled without delay, and a minimum of from 5 to 22 prints, except those made exclusively for mapping purposes, are prepared in accordance with the instructions of G–2.

c. Distribution of photographs.—One print is retained by the observation squadron, and the remaining prints and the negatives are sent to the G–2 of the unit to which the squadron pertains. The intelligence liaison officer from the corps

or army, if present, studies the retained print for information of immediate importance, which, if found, is transmitted to the G–2 of the higher unit by the most rapid means of communication available.

■ 18. ACTION OF G–2 UPON RECEIPT OF PHOTOGRAPHS.—*a. Redistribution.*—Upon the receipt of aerial photographs from the observation squadron, G–2 will ordinarily redistribute them as follows:

	Number of copies
Commander of next higher unit	1
Retained by G–2 of unit	2
Unit topographic company or battalion	1
Unit air officer	1
Unit artillery officer	1
Commander of subordinate unit requesting photograph [1]	([2])

[1] To be redistributed as directed by the commander concerned.
[2] Remaining copies (ordinarily not more than 15).

b. Final study for determination of military information.—One copy of each aerial photograph retained by G–2 should be studied in great detail, including stereoscopic examination if stereo-pairs are available, and in connection with other photographs of the same area and items of information made available by other collecting agencies, with a view of determining all possible military information shown on the photograph. The study should be coordinated with the specialized studies of other copies of the photograph made by the artillery intelligence section and the Air Corps intelligence service. Only when interpretation has been definitely made will items of information be reported as facts. All doubtful items will be referred to other collection agencies for verification. All items definitely determined will be disseminated by G–2 and considered by him in the preparation of estimates of the enemy capabilities and intentions. After this copy of the photograph has otherwise served its purpose, the area shown on the photograph and its serial number and date are entered on a graphic index map (fig. 5), and the photograph is then filed according to the area for future reference. The index of the 1:20,000 map will be the filing index. Each print will be filed in folders according to its coordinates, each folder to cover the area of one of the 1:20,000 map sheets.

c. Study to determine value as a map.—While the first copy of the aerial photograph retained by G–2 is being studied for military information, the second copy should be evaluated for its possible use by subordinate echelons of command as a map or as a supplement to existing maps. Based upon this study, G–2 will issue instructions to the appropriate topographic company or battalion for its reproduction by lithography or contact printing by the multiple rapid printer when available, and for its distribution to subordinate units. Each photograph will frequently be useful to subordinate units down to and including the infantry platoon and tank section. As many as 400 copies of such lithographs or contact prints may be required, and these must receive early distribution to be of maximum value. When this copy has otherwise served its purpose, it should be turned over to the officer charged with examination of enemy personnel, repatriates, and captured documents for possible use in connection with his work.

d. G–2 report.—In order that all elements of command may be informed of available photographs, a list of successful photographic missions will be included in each G–2 report.

■ 19. ACTION OF TOPOGRAPHIC ENGINEERS.—*a. Determination of topographic data.*—The copy of each aerial photograph furnished the topographic company or battalion should be studied in connection with the best available map, photomap, or mosaic with a view of determining topographic data that may be of value in any future revision of the map, photomap, or mosaic. When this study is completed, the print is filed for future reference in the same manner as prescribed in paragraph 18*b*.

b. Distribution of lithographs or contact prints.—From the negatives of each photograph furnished by G–2, the topographic company or battalion completes and distributes in the manner prescribed in FM 30–20 lithographs or contact prints of each aerial photograph as directed by the commanding officer.

■ 20. FILING OF NEGATIVES.—G–2 of the corps or army will maintain a file of negatives of aerial photographs. If requests are made for additional photographs, the topographic

company or battalion will be directed to reproduce as contact prints or as lithographs the necessary copies. Negatives will be retained by G–2 as long as required, ordinarily not longer than 3 months, and then sent to a central record section to be designated by the theater commander, where they will be filed for final disposition upon the termination of hostilities.

SECTION III

USE TO BE MADE OF AERIAL PHOTOGRAPHS

■ 21. GENERAL.—There are many uses for aerial photographs in modern warfare. They are of value not only in determining information of the enemy and the terrain but also in the preparation and execution of all types of operations. This section deals only with some of their more important uses as intelligence documents.

■ 22. AS A MAP.—*a.* Maps are graphic representations of the terrain; aerial photographs are detailed representations of the terrain as it appears at a particular time. Therefore, when properly titled, vertical photographs should be considered as maps, even though the exact scale is not known and some distortion of detail may exist. If taken shortly before the time of use they are extremely important as supplements to maps, showing all details at the time of exposure.

b. High oblique photographs taken in the direction of march are especially convenient and valuable as road maps. They are also of great value in the preparation of operation maps. However, there is a certain amount of danger involved in the use of the oblique as a map because of the distortion of scale and the false perception of increased elevation in the background of such a photograph.

■ 23. IN PREPARATION OF OBJECTIVE FOLDERS.—Aerial photographs of fixed installations, towns, bottlenecks on lines of communication, and important terrain features are extremely significant in air operations and should be included in objective folders whenever available. (Fig. 1.) They are also of great assistance in planning and executing mechanized operations.

■ 24. IN ENGINEERING PLANNING.—*a.* In planning the engineering work which will be required in territory held by the enemy, but over which an advance is planned, study of aerial photographs of the area is essential. The amount of destruction, actual or to be expected, can be estimated, width of structures or streams computed, amount of materials estimated, mine fields located, conditions of roads determined, location of engineering supplies revealed, and much other preliminary planning work completed, prior to occupation of the terrain.

b. Aerial photographs may be of great value in planning demolitions, particularly for demolitions over a large area. The photographs have greatest value in making detailed studies of demolitions in defiles and on river lines and in planning antitank mine fields. Since demolitions on a large scale are normally planned for terrain which is to be released to the enemy, photographs may frequently be secured at a larger scale than can be expected of terrain held by the enemy. In making the demolition plan, the study of these aerial photographs should supplement personal reconnaissance and assure that no important structures or works at critical points are overlooked. When time for personal reconnaissance is not available, aerial photographs are of maximum value and if of sufficiently large scale may reveal sufficient data on which to plan the demolition.

■ 25. IN PLANNING FOR ATTACK UPON FORTIFICATIONS.—Detailed information concerning defensive arrangements, areas that cannot be covered by the defender's fire, and camouflage, especially on lines of communication necessary for the attack of a fortification or fortified position, may be gained from a study of aerial photographs. Results of these studies should be confirmed by terrain studies and reconnaissance in force, if this is necessary. Based upon this information, the composition of the troops as well as the necessary equipment and material and the special training measures to insure the successful execution of the attack can be determined. (Fig. 8.)

■ 26. IN DETERMINING INFORMATION OF ENEMY.—*a.* If systematically exploited as a direct source and as a check upon

other sources, aerial photographs will disclose information about the enemy that can be obtained by no other means. Information derived from all sources should be coordinated and items from the various collecting agencies checked against each other and studied under the direction of the G–2 of the unit concerned. Latest aerial photographs should be compared with earlier ones to determine the most recent work or activities of the enemy.

b. An aerial mosaic of the area traversed by a prisoner of war or repatriated national is frequently of great value in the examination of such personnel. Based upon information which he furnishes, the route traversed by a prisoner prior to his capture is marked on a mosaic. The prisoner is then questioned concerning doubtful items shown on pinpoints along the route. In this way, much information is acquired concerning objects which otherwise cannot be identified. Information furnished by a prisoner or repatriate should be checked against items which are already known or verified by rephotographing and restudying the object. The accuracy of a prisoner's or repatriate's statements concerning items that have been definitely verified will establish the degree of credence to accord him.

c. Captured documents frequently constitute an excellent means of identifying objects on aerial photographs especially if made on the same date. Sketches should be carefully examined for notations of machine guns, mortars, fake works, and other items which can be checked by use of aerial photographs.

d. Appropriate artillery intelligence sections will study aerial photographs to determine enemy artillery activities and the location of bottlenecks on lines of communication, railheads, dumps, observation and command posts, and bivouac or assembly areas. The work of the artillery intelligence sections of subordinate echelons is reviewed and their findings compared with and incorporated in those of the artillery section of the higher unit. In this manner the enemy artillery situation on the front of the division, corps, army, and the entire front is established and kept up to date.

■ 27. By Artillery.—Aerial photographs are of particular value to the artillery in the determination of targets and the

effect of fire. (Figs. 9 and 10.) In the absence of an accurate map, they are indispensable as a means of planning fire support and of controlling unobserved fire. They are very useful in the reconnaissance and selection of positions and of routes thereto; by the use of suitable aerial photographs many artillery survey operations may be avoided. They are valuable in testing the effectiveness of artillery camouflage and are a means of verifying the reports of other information gathering agencies such as observation battalions.

■ 28. IN LANDING OPERATIONS.—*a.* Aerial photographs of beaches and the adjacent terrain made prior to a landing will prove of greatest value. (Fig. 11.) In good weather both natural and man-made obstructions to landing operations can be located from photographs. The nature of the beach, whether steeply shelving or gently shelving, which is very important to a landing force commander in his decision as to the feasibility of landing on a certain beach, can also be determined. A very accurate estimate of wave heights can also be made from a study of stereoscopic pairs. Color transparencies are especially valuable in studies of the beaches and frequently reveal the unobstructed channels and the nature of the bottom.

b. Photographs taken during and after landing, if completed by the quick work process, will prove of the greatest value in determining the enemy reaction and the progress of our own troops. They should be delivered to the troops ashore as well as to the higher command afloat.

■ 29. IN RIVER CROSSINGS.—In planning a river crossing, aerial photographs should be made of those reaches of the river for which crossings are contemplated. These photographs, particularly when examined stereoscopically, will facilitate the selection of ferrying points and bridge sites for the various crossings. They may reveal conditions existing on both sides of the river, the character of the river banks, the river bed, the location of underwater obstructions, both natural and man-made, the defensive arrangements of the enemy, and the location of shoal spots or rapids in the river. Cover for preliminary concentration of material may also be located by study of aerial photographs. (Fig. 12.)

■ 30. IN COUNTERINTELLIGENCE.—*a.* Aerial photographs of areas or positions occupied by our own troops furnish the very best evidence of success or failure of counterintelligence measures adopted for the protection of troops on the ground. Faulty camouflage work, breaches of camouflage discipline, and failure to utilize natural cover may be detected easily on photographs. (Figs. 13 and 14.) Photographs are also valuable in planning dummy works, installations, and airdromes and in checking their deceptive worth.

b. Photographs are of great importance to the engineers charged with the development of measures for the protective coloration and camouflage of individual and organizational equipment and matériel.

SECTION IV

IDENTIFICATION OF OBJECTS FROM AERIAL PHOTOGRAPHS

■ 31. GENERAL.—Man is accustomed to viewing objects horizontally or, if looking down from a height, obliquely. A vertical aerial photograph portrays military objects in an unfamiliar aspect. Objects which form regular lines, in general, are easy to identify on aerial photographs, but difficulties are encountered in identifying concealed or small objects which present no contrast of shade with surrounding objects, and in identifying deliberately concealed military features. The solution of these difficulties requires special knowledge, training, and experience.

■ 32. PURPOSE.—The purpose of identification is to determine the objects shown on an aerial photograph and to discover obscure or hidden features through related visible ones.

■ 33. BASIS OF IDENTIFICATION.—*a. General.*—To identify objects shown on aerial photographs, the examiner relies in general on familiarity with the characteristic appearance of certain objects on aerial photographs, shadows, texture, differences as compared with former photographs, and information from other intelligence sources.

b. Characteristic appearance.—Through experience gained in working with aerial photographs and by frequent flights

in the air, the interpreter should acquire a knowledge of the appearance of objects as viewed from above.

c. Light and shade.—(1) *General.*—Objects on aerial photographs are generally identified by a study of light and shadows. If not correctly understood, shadows will give a reversed impression, causing elevations to appear as depressions and depressions as elevations. *Vertical aerial photographs should be held so that the shadows fall toward the examiner.* In an oblique aerial photograph, shadows play no part. If observed in the direction of exposure, they will give a clear impression of what has been photographed.

(2) *Shadows and form.*—Shadows will show the shape of an object which is perhaps otherwise unrecognizable on a vertical photograph.

(3) *Shadows and size.*—The shadows cast by different objects will be in direct proportion to their height. The approximate size of objects may, therefore, be determined by comparing their shadows with those of objects of known height. This should be done with caution because of the effect of slope of ground upon length of shadow.

(4) *Shadows and relief.*—While gentle slopes usually cannot be distinguished on vertical aerial photographs, the crests of sharper slopes as a rule may be identified by the difference in light reflected by the two slopes. Ravines and the deeper depressions are indicated by the darker coloring of such areas. Hills may also be indicated by their shadows.

(5) *Shadows and camouflage.*—Shadows will reveal camouflage which otherwise might be invisible. Fake shadows which are sometimes employed in camouflage work should be easily identified on aerial photographs.

d. Texture.—The arrangement of the constituent parts of a material is known as "texture." A change in this arrangement has a direct effect upon the reflection or absorption of light and therefore upon photograph negatives. As footprints, trails, tracks, spoil, works, and sometimes camouflage itself cause a change in the texture of the earth's surface or the vegetation thereon, they will be revealed on aerial photographs and will establish a record of many activities in a given area.

e. Confirmation.—Information gleaned from aerial photographs should be confirmed by evidence from other collecting agencies whenever possible. Liaison between the specialist examiner of aerial photographs and assistant intelligence officers specializing in other fields should facilitate this work.

■ 34. METHOD OF EXAMINATION.—*a. General.*—Aerial photographs should be examined systematically and objectively. The examiner should concentrate on each detail of a photograph. He should avoid jumping at conclusions, but should bear in mind every possible identification of any particular detail. After considering the various probabilities, he should determine whether or not there is sufficient evidence to justify a definite decision. Photographs taken on a single mission may give little definite information, but if considered with other photographs, intelligence summaries, and statements of prisoners, much valuable positive or negative information may be obtained.

b. Procedure.—(1) *Preliminary examination.*—The preliminary examination begins with the orientation and location on the best available map of the area shown on the photograph. Conspicuous terrain features, such as stream lines, railways, highways, and villages, are oriented with the map. The photograph is first examined with the naked eyes. After this is completed, a detailed examination of the picture is made with a magnifying glass and with a stereoscope, if stereo-pairs are available, to determine information that might have been overlooked.

(2) *Comparison of old and new photographs.*—A comparison of old and new photographs of the same area will reveal changes which have been made in the intervening period. On arriving in a new area, it is advantageous to photograph the terrain to show its exact condition at the time of arrival. Later this will facilitate the gathering of information in the area. Upon relief, a unit should turn over its file of photographs to the relieving unit.

(3) *Study of area as a whole.*—The defensive organization of an area is generally based upon a plan which coordinates all defensive arrangements. Information derived from a study of an aerial mosaic of the area, supplemented by information from other sources, frequently makes it possible

to determine, at least partially, the enemy's plan of defense. The study is facilitated by low oblique photographs.

(4) *Study of details.*—Details are studied on vertical photographs and stereo-pairs, supplemented at times by oblique photographs. The actual examination of stereo-pairs should be made in a good light with the aid of a magnifying glass and a stereoscope. The examiner should study each object in detail, covering the whole photograph in a methodical manner. He should suspect all regular forms, as there are few geometrical figures or straight lines in nature. *He must try to establish facts and in doing so should confine himself to military essentials.* The examiner should be thoroughly familiar with the terrain and all available enemy information in the area under consideration. He should compare the photographs with a map of the area, for this will enable him to avoid serious errors.

(5) *Annotation.*—Aerial photographs should not be marked or annotated until they have been thoroughly examined and then only in such a way as not to obliterate detail. Objects should be indicated on the photograph without obliterating essential detail. A distinction should be made between objects actually identified and those located from prisoners' statements or otherwise. If markings are made on the photograph, the ordinary conventional signs should be used. The names of topographic features, such as villages, trenches, roads, and map coordinates, should rarely be shown on photographs. (Fig. 15.)

(6) *Report.*—The final report is made by noting the results of the study on the photograph by means of a sketch, or by sketching the items on tracing paper pasted to the aerial photograph. A complete report must answer the questions: What, where, and when?

SECTION V

IDENTIFICATION OF ENEMY ACTIVITIES FROM AERIAL PHOTOGRAPHS

■ 35. GENERAL.—*a.* Military operations have a profound effect upon the terrain of the area involved, depending, of course, upon their intensity and the size of the forces engaged.

These activities make marks upon the terrain which are reproduced on aerial photographs and thus become a source of valuable military information.

b. The methods used in studying enemy activities are similar to those employed in ordinary aerial photograph reading except that greater attention is paid to minute details, for the smallest detail on an aerial photograph taken during active operations may be of great importance.

■ 36. CAMOUFLAGE.—The enemy will try to make objects deceptive or invisible to the eye and camera, but generally it is not possible to accomplish both at the same time. Camouflage invisible to the eye is occasionally visible to the camera, and vice versa. Color effects are generally used to camouflage from the eye. To camouflage from the camera, nets may be used to break up shadows, and tracks and blast marks may be covered up or concealed by confining them to locations near roads or hedges or inside buildings where they cannot be seen. Spoil may be covered up, scattered, or disguised. Breaches of camouflage discipline tend to defeat the best efforts at concealment by means of artificial cover. Ordinary camouflage is more visible after a snowfall. With a white background a different type of camouflage is required. For more complete information see FM 5–20. (Figs. 14 and 16.)

■ 37. ROADS, TRACKS, AND PATHS.—*a.* Roads, tracks, and paths are among the most revealing features of enemy activities found on aerial photographs. Dead-end trails and roads are of especial significance. An abrupt ending usually means that some activity such as a dump, an observation post, or a machine-gun emplacement is near the end of the trail or path. Development and deployment for action will show up clearly in maneuver warfare in all but close terrain. In defensive operations, tracks and paths will disclose the enemy's activities in great detail, frequently furnishing the clue to the location of many defensive installations. The main communication trenches will generally be indicated by paths parallel to them, which are made by carrying parties at night. Trenches in bad condition are also frequently indicated by parallel paths. On quiet parts of the front the appearance of new tracks or the gradual disappearance of

tracks will frequently give positive or negative information of the enemy's activites in a locality. During artillery preparation, new tracks near dugouts under bombardment are sure signs that the dugouts have not been destroyed or that they have been reoccupied. Tanks and other mechanized weapons moving into assembly positions make unmistakable tracks. (Figs. 17, 20, 22, 23, and 25.)

b. The presence of troops may be disclosed by the cutting of new paths, trails, or roads, by fire or smoke, and by a general lightening of the appearance of the area. The presence of vehicles may be disclosed by the disruption of the road shoulder at the point at which they left the road, and the crushing of the vegetation incident to their movement into concealed positions which show very plainly in night as well as in day photographs. Troops deploying for action leave unmistakable trails and tracks as they fan out from march columns. Marching troops are easily detected on main roads but are more difficult to detect if they use the shoulders. Dust arising from dirt roads will reveal troop movements even in heavily wooded areas. (Fig. 25.)

■ 38. TYPES OF WORKS.—*a.* The works, installations, and tactical dispositions employed by various armies in different situations will vary in details of shape, appearance, and relative locations. The types of works used by the enemy must be carefully studied, especially those on ground recently captured. G–2's of higher echelons should keep an album of interpreted aerial photographs for use in studying new photographs.

b. The illustrations in this manual are largely from the World War and exemplify what was accomplished at that time with available means under the conditions of position warfare.

■ 39. TRENCHES.—*a.* Trenches are readily distinguished by their traversed or zigzag trace revealed by the shadow of trench walls or by spoil. Shadows indicate the depth; shallow, dummy, or incomplete trenches cast little shadow. The conspicuousness of spoil depends upon the type of soil and the newness of the work, chalky or light-colored spoil being very difficult to conceal. Recent work is generally indicated

by a different appearance than surrounding soil. Any unusual amount of spoil should be scrutinized carefully, as it may indicate subterranean work. When a trench system has been heavily shelled, the previous contrasts rapidly disappear, and the study of photographs becomes increasingly difficult. Trenches in use are generally more distinct in outline than those not being used because they are kept in condition, but aerial photographs can seldom be relied upon to indicate whether or not they are occupied. (Figs. 26 to 29, incl.)

b. Fire trenches usually have straight firing bays separated by variously shaped traverses, while communicating trenches generally zigzag.

c. Trenches can be analyzed in snow pictures, due to the contrast of the shadows against the white background. If the trenches are occupied, the repeated trackings of the men may show, and dummy trenches are easily identified from real trenches. (Fig. 30.)

■ 40. BREASTWORKS.—Breastworks are usually constructed in city streets or in marshy or swampy terrain where trenches would quickly fill with water. They may be identified by their regular trace and characteristic shadows.

■ 41. ORGANIZED SHELL HOLES.—*a.* Shell holes are frequently organized for defense. They may be prepared and organized prior to an offensive or consolidated quickly during a battle.

b. When systematically organized, shell holes will generally be in pairs, constructed in well-drained ground, and connected by underground passages leading to a common dugout. The sides of shell holes may be revetted and the tops roofed and camouflaged. Such shell holes are not difficult to find on large scale photographs, and may be distinguished from ordinary shell holes by their more definite outline, the spoil dumped in the vicinity, tracks, and the entrance to the dugout.

c. Makeshift shell hole systems are more difficult to detect, but may be distinguished from ordinary shell holes by their darker appearance if they have been deepened. Occupied shell holes are generally found on patches of dry ground, which should be scrutinized carefully. Tracks are by far the surest indication of occupancy.

■ 42. WIRE.—*a.* Broad wire entanglements show on photographs as a band or line varying from light to gray to almost black, depending upon the age of the entanglement and its contrast with the color and texture of the adjacent ground and vegetation. New wire is more difficult to detect than old wire, as grass and other vegetation growing in old areas give them a distinctive, darker appearance. The study of photographs to locate wire should include not only the trench system but also fortified shell holes, battery positions, villages, hedges, and ditches. (Figs. 27 to 29, incl.)

b. As ground is cut up by bombardment, wire becomes increasingly difficult to identify. It should not be concluded that no wire exists because there are no signs of it on a vertical photograph. An oblique photograph may reveal wire not visible on a vertical photograph. (Fig. 29.)

c. The presence of wire may be betrayed by the tracks of working parties on either side of it, or by paths which suddenly change direction in passing through the entanglement.

d. As wire appears as a black band in snow, it is then visible when not otherwise apparent. It is rarely possible to discover wire entanglements in woods. (Fig. 30.)

■ 43. DUGOUTS.—The first indication of a dugout is usually the spoil thrown up during its construction. Earlier photographs of a defensive system should be compared with more recent ones in order to discover fresh spoil, which should be carefully noted, as the actual location of the dugout may be concealed by scattering the spoil. Frequently the first indication of a new defensive position is the appearance of a line of dugouts. The position of these dugouts should be carefully plotted, as they may be so camouflaged as to be no longer visible in photographs taken after the trench has been completed. The size of dugouts may sometimes be estimated by the amount of spoil. Occupied dugouts are sometimes revealed by the melting of snow from the heat of the fires inside.

■ 44. MACHINE GUNS.—*a. General.*—Machine guns are so difficult to locate on photographs that as a rule they can be detected only by knowing where to look for them. Aerial

photographs should be used mainly to corroborate reports from front-line troops and information from other sources.

b. Mobile situations.—Because machine-gun emplacements are simple in type and utilize all available natural cover, it is extremely difficult to identify them in mobile situations. In the attack, machine guns are generally placed on high ground where they can furnish support by overhead fire or grouped in batteries on a reverse slope about 1,500 yards in rear of the front line. In the defense, they will be found in positions with a good field of fire and covering approaches, such as ravines, bridges, etc., or flanking the edges of woods or elevations. High ground is usually defended by guns posted on the flanks of the elevation instead of on the crest. Ground which offers the best positions for flanking strong points should be carefully studied, for machine guns are often posted about 1,000 yards from the defenses which they protect by flanking fire. Sometimes they are indicated by the absence of wire and grass in the field of fire. When a machine gun location is suspected—

(1) Look carefully for tracks between the position and the roads or paths.

(2) As a machine gun is rarely employed alone, look for indications of adjacent machine-gun positions.

(3) Draw an arc with the position as the center to determine the probable field of fire.

(4) Note if the field of fire of the machine gun covers the terrain effectively; if it does not, look for a probable new position.

c. Position warfare.—In position warfare, machine guns are generally located close to the trenches, so they can deliver cross fire along the front of wire belts or cover the flanks and rear of fortified areas. Open emplacements in a trench can usually be recognized by the firing platform cut into the parapet, and covered emplacements by the V-shaped embrasure. They may be found—

(1) Where an angle occurs in the trace.

(2) Within easy reach of a communication trench.

(3) At the end of a path in front of a trench.

(4) Outside the trench system where a small forward sap leads to an emplacement protected by a semicircle of wire or in excavations behind the front line.

(5) In wire or on higher ground behind first-line trenches.

■ 45. 37-MM GUNS OR SIMILAR WEAPONS.—In searching for the positions of 37-mm guns or similar weapons, the examiner should understand the characteristics of the weapon and then proceed in the same manner as outlined for machine guns.

■ 46. LISTENING, OBSERVATION, AND COMMAND POSTS.—*a. Listening posts.*—Listening posts appear on aerial photographs as small excavations either under the first belt of wire or just behind it. Their positions are generally disclosed by tracks and saps leading to them. Detached listening posts are frequently constructed in no man's land. They may be camouflaged, encircled by wire, and provided with a covered approach. If the contour of the ground permits, listening posts may also be used as machine-gun positions. (Fig. 31.)

b. Observation posts.—(1) Observation posts are usually carefully camouflaged. They should be looked for on commanding ground in the vicinity of deep shelter or in or near such objects as a group of trees, hedges, or structures. They are often near the end of a dead-end path and should be suspected whenever a trail or path ends.

(2) An observation post is indicated by tracks or paths, telephone lines, and in organized ground by small trenches leading off from the main system.

c. Command posts.—Command posts will generally be located in buildings, in protected positions on reverse slopes, and in sheltered woods. They will usually be revealed by the trails, paths, or telephone lines which converge upon them. Panels for communication with friendly aviation will frequently reveal the location of command posts. (Fig. 32.)

■ 47. ANTITANK OBSTACLES AND ROAD BLOCKS.—*a.* In an organized position, antitank obstacles may consist of ditches, wire rolls, concrete pillars connected by steel cables, concrete blocks, railroad rails embedded in the ground or in concrete, wooden piling, or rubble masonry. An antitank mine field, consisting of a broad band of contact mines either buried or laid checkerwise on the surface of terrain suitable for the movement of

tanks or mechanized vehicles, constitutes an effective obstacle. Such mine fields may be detected by spoil, paths, or vehicle tracks parallel to the front.

b. In mobile situations, tank traps, and road blocks will usually be found along roads, generally at defiles or at crossroads. In order to hold the vehicle under fire a barrier is built consisting of a ditch, a covered or uncovered crater with vertical sides, or a heavy obstacle. Antitank mines will normally be found in or flanking the exposed sides of the barrier. Crossroads, defiles, causeways, bridges, deep road cuts, and side hill road cuts, as well as adjacent fields, should be examined for these articles. (Fig. 33.)

■ 48. MINE SHAFTS.—Mine shafts are difficult to distinguish on an aerial photograph, because great care is usually taken to conceal the spoil, which is often carried some distance by light railways. Proper interpretation can best be made by experts who are familiar with the mining technique. The results of mining operations can be checked by means of aerial photographs. (Fig. 34.)

■ 49. CONCRETE FORTIFICATIONS.—As concrete fortifications are located with a view of avoiding observation, or are provided with artificial concealment, they are often difficult to identify until the whole area has been cleared by heavy shell fire. After intense bombardment they appear on a photograph as geometrical figures standing above the level of the ground, having in most cases survived the prevailing destruction due to their superior powers of resistance. Concrete fortifications under construction are often disclosed by the whiteness of the concrete and the appearance of the ground where the concrete was mixed, by tracks of vehicles, or by narrow gage lines which transported the material (Fig. 35.)

■ 50. LOCATION OF BATTERIES.—*a. Natural cover.*—The enemy will take every precaution to conceal battery emplacements, utilizing villages, hedges, ditches, orchards, woods, thickets, ravines, and sunken roads for the purpose. Positions in the open may be dug in. They are usually provided with camouflage. Emplacements in ravines and sunken roads are frequently dug in and so well hidden that they are difficult to

locate, as the roads, being used for other purposes, will not show any signs of extra activity near the batteries. The primary considerations in the location of batteries are to provide concealment and cover for men and guns. Unless the batteries are in or near a village where the personnel can be housed in adjacent buildings or cellars, each battery will usually have dugouts and ammunition dumps close to the gun positions. During an advance or withdrawal, however, battery positions will generally afford no protection either for the personnel or for the guns, although locations near a road or some natural feature of the ground may give some protection. For each battery position a number of dummy or alternate emplacements are usually constructed. (Fig. 36.)

b. Artificial cover.—Natural cover will be supplemented by camouflage designed to furnish the maximum protection from both ground and aerial observation. Positions in the open will be camouflaged if time permits. Alternate and dummy positions will be constructed for purposes of deception. (Fig. 37.) Antiaircraft artillery is difficult to camouflage from aerial view. Patches in woods which appear lighter or darker than their surroundings may indicate the location of artillery positions. Such areas should be carefully studied for additional indications, such as trails and paths.

c. Evidence of battery positions.—(1) Batteries are usually spotted on photographs by tracks leading to them, by increased traffic on nearby roads and trails, by faulty camouflage, by piles of ammunition, and by latrines, dugouts, bivouacs, and kitchens. Sometimes horse lines or vehicles can be seen. Guns are only a part of the evidence of the existence of a battery. Batteries concealed by overhead cover may be detected by trails or narrow gage railroads leading to them, or by the tracks of the gun crew. Even if the battery emplacement is hidden, it is difficult to conceal the activity in its vicinity. Blast marks made by the guns tend to defeat camouflage, showing up as white scores where the surface has been blown away by the discharge and as black smudges on snow. During dry weather, blast marks may be visible for some time after the position has been vacated, and so are

no proof that an emplacement is occupied, but rather that a position has been active—a distinction which is liable to be overlooked. A photograph revealing blast marks when snow is on the ground usually indicates an active emplacement but may be only a well-prepared dummy. (Figs. 38 to 40, incl.)

(2) Guns hidden by camouflage or protected by overhead cover and firing through embrasures may be detected by the shadow of the camouflage or by blast marks. Dummy batteries can usually be distinguished by the exaggerated blast marks and tracks of too regular a pattern. The stereoscope is essential in studying such positions.

(3) Batteries in the woods are revealed by slashings, by white marks on the ground due to construction of emplacements or to traffic around guns or shelters, and by trails, narrow gage railroads, and wire lines leading to battery positions.

(4) Antiaircraft guns are generally grouped by batteries of three or four guns in regular pattern. (Fig. 14.)

d. Study of our battery positions.—Examiners should study photographs of our own battery positions taken during both peace and war, so that they may be familiar with the appearance of batteries in different situations.

■ 51. STUDY OF EFFECT OF OUR OWN ARTILLERY FIRE.—Aerial photographs may be used in adjusting artillery fire and in studying its effects. Photographs taken for these purposes should be developed by quick work methods and made available at the earliest practicable moment. (Figs. 41 and 42.)

■ 52. BURIED CABLES AND OVERHEAD TELEGRAPH AND TELEPHONE LINES.—*a. Buried cables.*—Open cable trenches can usually be distinguished on photographs by their fairly straight course and construction, and by their irregular outline when filled in. They should be marked on a map when first discovered, as they are difficult to find after being established for some time. Cable trenches aid in discovering command posts, headquarters, telephone exchanges, camouflaged batteries, observation posts, and other important centers.

b. Overhead lines.—Overhead lines appear as regularly spaced white dots, these being the displaced earth where the

poles have been erected. These dots are connected by a thin white track made by the men walking from pole to pole when putting up the wire. Overhead lines in a cultivated field will frequently stand out clearly as small dark spots because the soil around the posts has not been disturbed. Overhead lines can be determined on clear photographs if the shadows thrown by the poles can be seen. In melting snow the overhead lines may appear as evenly spaced black dots.

c. Ground lines.—Advancing troops lay ground lines as they progress. These always lead from one important communications center to another. The repair of these lines caused by frequent breaks goes on constantly and results in the making of telltale tracks or paths.

■ 53. REAR INSTALLATIONS.—*a. General.*—Military operations require large concentrations of troops, ammunition, and supplies; the construction of airdromes and hospitals; the preparation of railheads, detraining points, and other facilities. All of these are generally revealed by aerial photographs. A study of the area in rear of the enemy's front lines is, therefore, highly important.

b. Reserves.—(1) Local reserves are held in concealed positions close to the front. Evidences of their presence which may be found on aerial photographs are huts or other temporary shelters, numerous paths and tracks, picket lines and motor or gun parks, watering places, and kitchens.

(2) General reserves are usually held well back from the front or in training camps still farther to the rear. Large billets, extensive training facilities, and considerable activity are evidences of their presence. (Fig. 43.)

c. Supply and ammunition dumps.—Depots and dumps are points of supply for front-line units. Their location depends upon the accessibility of railroads and highways. Points where various means of communication join should be carefully examined. If open storage is used, dumps can usually be identified by the regular segregation of the various types of property. Forward supply points are usually more carefully concealed or camouflaged than those in the rear. Because of the increased range and importance of aviation, it will be necessary to camouflage all supply installations. They may be detected on aerial photographs by signs of activity

in their vicinity. Supply points become smaller toward the front. Signs of unusual traffic at certain points will indicate the location of forward dumps even when concealed. Abandoned dumps will soon show lack of use. (Figs. 44 and 45.)

d. Detraining points.—Military activity at detraining points is difficult to conceal during daylight hours and may even be detected at night. Aerial photographs will frequently reveal not only the detrainment but also the composition of the forces detrained. They are also of value as a check on the results of aerial bombardment. (Figs. 46 and 47.)

e. Hospitals.—Hospitals are generally located on railroads or other lines of communication at points where there is no ammunition. They are usually identified by the Red Cross sign but in the forward areas may be concealed or camouflaged. (Fig. 44.)

f. Landing fields and airdromes.—(1) Enemy aviation will probably be widely scattered throughout his rear. On the ground the airplanes will be concealed by camouflage or natural cover and may be provided with overhead protection.

(2) Enemy airdromes and landing fields may be indicated by hangars; by landing devices, such as tees, smoke contrivances, lights, and wind vanes; by especially prepared landing areas and distinctive accessory buildings which are difficult to camouflage or conceal. (Figs. 48 to 50, incl.)

(3) Permanent airdromes may be built underground, and the landing fields may be concealed by natural planting supplemented by camouflage.

g. Balloon beds.—Captive balloons behind the enemy's front lines are extremely difficult to conceal except when deflated.

SECTION VI

INTERPRETATION

■ 54. GENERAL.—Information derived from aerial photographs and all other evaluated information will be given consideration by G–2 in the preparation of his conclusions relative to the enemy's capabilities. The procedure followed is outlined in FM 30–5.

■ 55. EVIDENCE OF ENEMY'S INTENTIONS AS REVEALED BY AERIAL PHOTOGRAPHS.—*a. General.*—The general attitude of the

enemy, whether offensive or defensive, can usually be ascertained by a study of aerial photographs in connection with information from other sources. The kind and degree of completion of enemy works, the number and location of dumps, and the amount and location of reserves, if shown on aerial photographs, will furnish evidence of the offensive or defensive plans of the enemy. Aerial photographs will be of greatest utility in these studies during periods of stabilization. In maneuver warfare it will be difficult to distinguish between offensive and defensive preparations.

b. Offensive preparations.—(1) *General.*—Offensive preparations by the enemy usually leave unmistakable marks upon the terrain, which, if properly interpreted in connection with information from other sources, furnish the commander advance notice of the enemy's intentions. Among the indications of an impending attack may be an increase in artillery and antiaircraft artillery battery positions, and a general forward displacement of mechanized units, artillery, reserves, airdromes, and supplies, and dumps of bridge material near a river. New or improved roads, deviations from existing roads, new or extended railroad lines, and a general increase in both road and railroad traffic may also be observed.

(2) *Position warfare.*—New and improved communication trenches, new and unusual trails, saps pushed in advance of the front line and linked up to form jumping-off trenches, new and improved dugouts and assembly trenches, new trench mortar emplacements, such as shell holes connected by trenches, new practice trenches, sometimes modeled after our own, and new gas projection emplacements may furnish indications of an attack.

c. Defensive preparations.—Defensive preparations are indicated by tank barriers or obstructions, by traverses and dugouts marking an intended new line, by strengthening and deepening of trenches, by additions to existing wire, by new switch trenches, and by an increase in battery positions especially toward the rear. After a defensive position has been well-defined, it will be studied for the distribution of defending troops, for details of organization, and for the probable routes by which reserves can be engaged. The study should include both front and rear, and should anticipate the en-

trance into line of division reserves and even of reinforcing divisions for sustained counterattacks. Therefore, all shelters, camps, roads, observation stations, and battery emplacements in the rear zone will be given the closest attention.

■ 56. INTERPRETATION DURING OUR OWN OFFENSIVE OPERATIONS.—*a.* In position warfare, interpretation during our own offensive operations falls into three distinct phases:

(1) Preparatory.

(2) Destruction of enemy's works.

(3) During and after an attack.

b. Preparatory.—The purpose of studying aerial photographs in conjunction with maps in preparation for offensive operations is to give the various elements of command detailed information concerning critical terrain features and bottlenecks on the enemy's lines of communications and the disposition of his troops on the ground and their defensive organization. Evaluated photographs are used by all elements as supplements to the designated maps. They are of particular importance to the Air Corps, parachute troops, air infantry, and mechanized troops and in operations incident to landing on a hostile shore or a river crossing.

c. Destruction of enemy's works.—(1) The aerial photograph is of real value in studying the destruction of enemy works. It shows the effect of our artillery and aerial bombardment and can be studied and compared with older photographs of the same area, thus facilitating the evaluation of operations in preparation for an attack. Three degrees of destruction should be considered: Destroyed, seriously affected, and only slightly affected. A field work should be considered destroyed when its offensive value has been reduced to a condition equivalent to that of connecting shell holes. It has been seriously affected when it can only partially fulfill the function for which it was intended. It is only slightly affected when it is still able to fulfill its defensive role.

(2) The degree of destruction of enemy works may be shown by marking each hit on the photograph. An overlay is then prepared showing in different colors the areas corresponding to the three classes of destruction indicated above.

These overlays should also show any works reconstructed or maintained by the enemy in spite of the bombardment. Such overlays should be prepared at the close of the day or at designated hours.

d. During and after attack.—(1) *During battle.*—Aerial photographs taken during battle may reveal among other things the—

(*a*) Position of attacker.
(*b*) Location of hitherto unknown defenses.
(*c*) Preparations for withdrawal or counterattack.
(*d*) Movement of reserves and their destination.
(*e*) New targets for our artillery.

(2) *After battle.*—After battle, aerial photographs may give the most accurate information concerning the situation, revealing among other things the organization and the connection of shell holes to form trenches, the construction of temporary dugouts, the location of obstacles, and the movement of reserves for counterattack. They are of greatest value in determining whether or not trenches or their remains are occupied by the enemy. The only sure indication of activity is the presence of trails for supply and relief. Aerial photographs taken during and after battle should be carefully studied for indications of new command posts, location of reserves, supply arrangements, communications, and new locations of machine guns and artillery.

FIGURE 1.—One photograph of pinpoint of communication center at Thiaucourt 21 Aug 18. Scale 1:7,800.

FIGURE 2.—High oblique photograph.

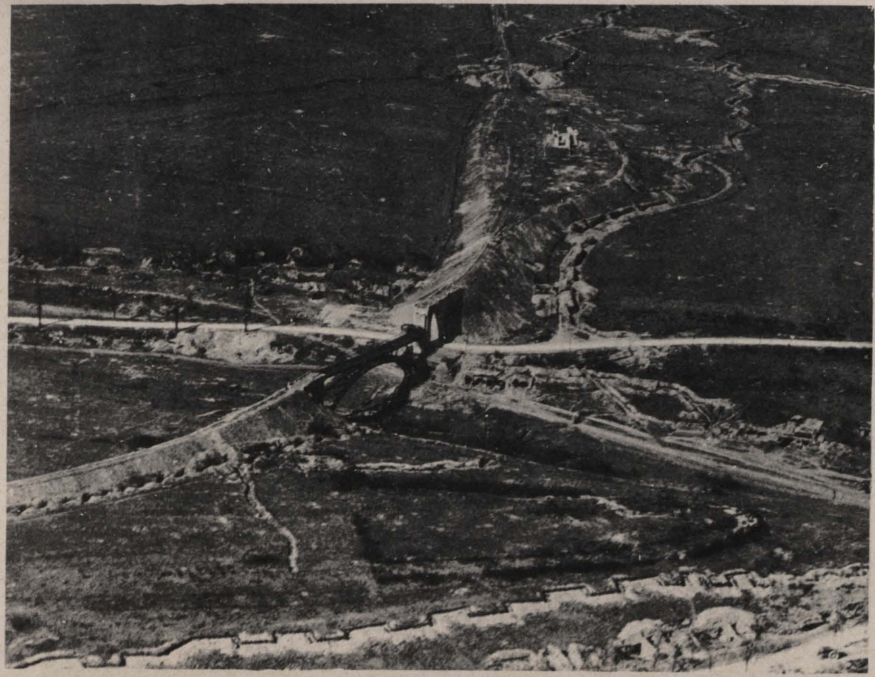

FIGURE 3.—Low oblique photograph showing demolished railway bridge west of Flirey and trenches.

FIGURE 4.—Night photograph taken at 5,000 feet showing faulty disposition of airplanes.

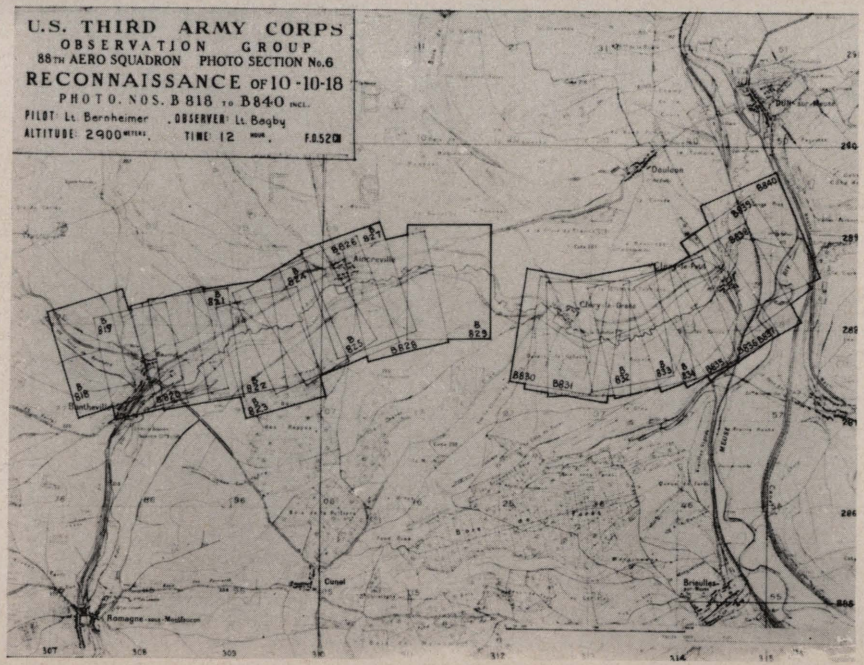

FIGURE 5.—Graphic index map.

FIGURE 6.—Method of titling a vertical photograph.

FIGURE 7.—Method of titling an oblique photograph.

FIGURE 8.—Photographic study of section of Siegfried line east of Sarrebruck. 30 Sept. 39; scale 1:4,000. Note recent work and older work at bottom of photograph; tank barriers; casemates connected by communication trenches.

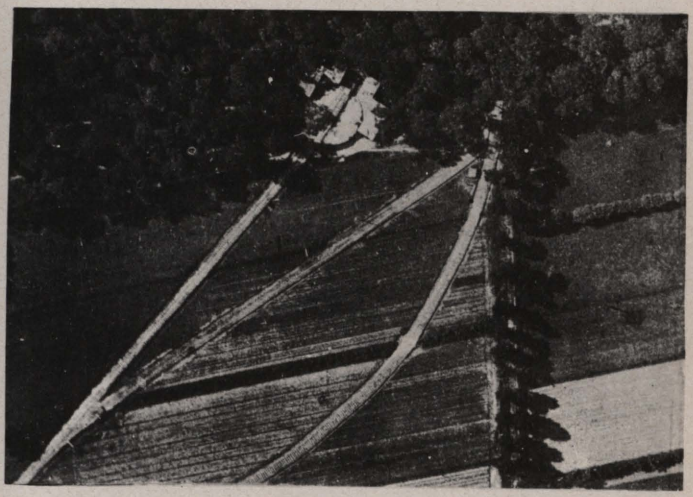

FIGURE 9.—Railway artillery position under construction.

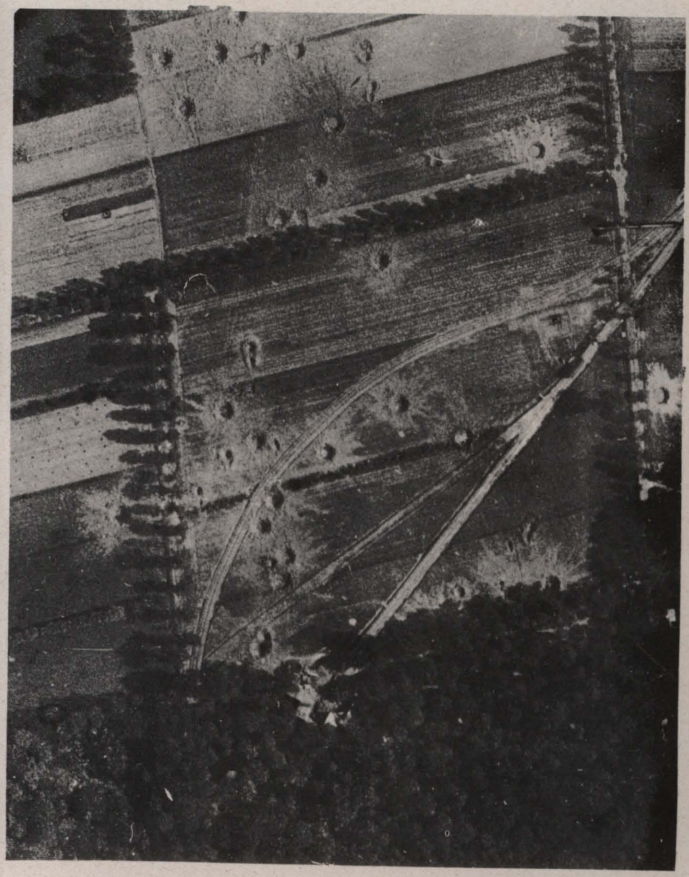

FIGURE 10.—Registration on railway artillery position shown in figure 9.

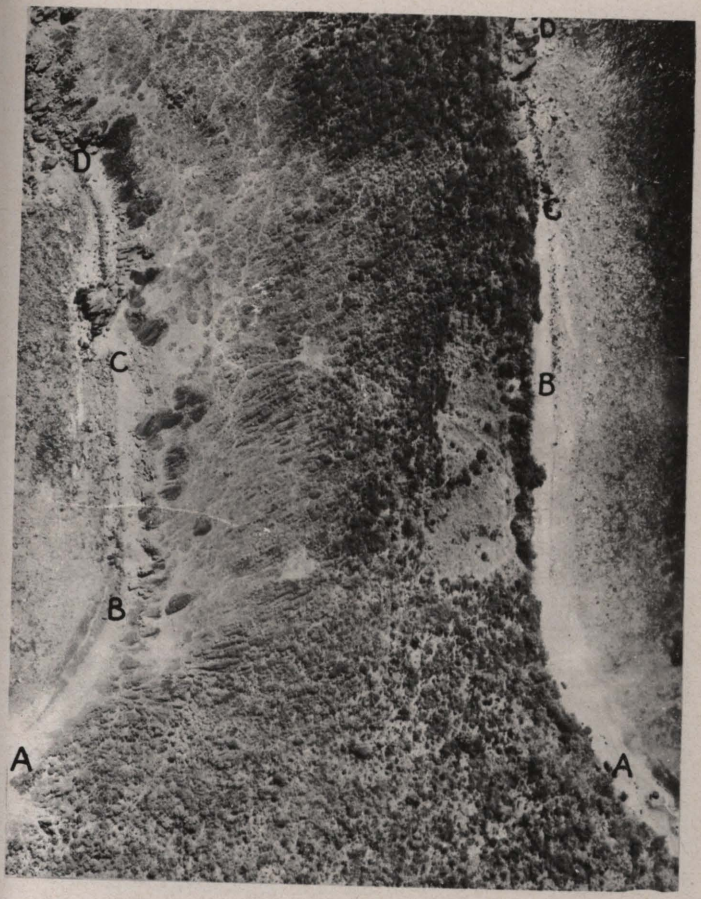

FIGURE 11.—Photographic study of possible landing beaches by 1st Marine Aircraft Group; scale 1:2,900. A–B, sandy beach with trails leading thereto and with no under-water obstructions offshore; B–C, narrow beach with steep banks inland and under-water rocks offshore, not satisfactory for landing; and C–D, rocky shore line with no beach.

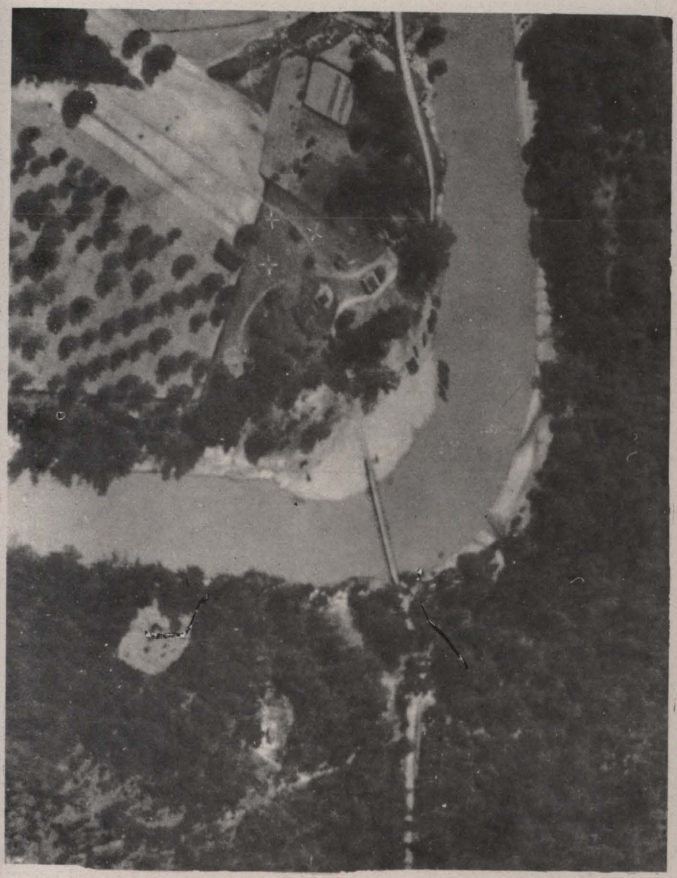

FIGURE 12.—Ponton bridge north of Burr Ferry, La., taken at 20,000 feet with 60-inch focal-length camera; antiaircraft artillery gun positions plainly visible.

FIGURE 13.—Night photograph of a bivouac area near Leesville, La., 24 May 40; scale 1:4,400. Trucks lined up draw immediate attention; available cover has not been utilized.

FIGURE 14.—Antiaircraft artillery gun positions southwest of Leesville, La., 20 May 40; scale 1:3,000. Faulty camouflage work and tracks disclose location.


chars
le anti-chars

FIGURE 15.—Method of annotation used by the French section of the Siegfried line northeast of Wissembourg, 25 Mar 40; scale 1:7,000.

FIGURE 15.—Method of annotation used by the French section of the Siegfried line northeast of Wissembourg, 25 Mar 40; scale 1:7,000.

FIGURE 16.—Faulty camouflage and disposition of aircraft on the ground. Neither the hangars nor the camouflage painting conforms to the ground pattern. The aircraft are not scattered.

FIGURE 17.— Truck movement near Fort Benning, Ga., 22 Apr 40; scale 1:5,000.

FIGURE 18.—British photograph of demolished bridge over Albert Canal at Locht; newly constructed light ponton bridge. Road mine and troops detouring around the mine can be observed.

FIGURE 19.—Trucks near Flatwood, La. Photograph taken at 23,000 feet with 60-inch focal-length camera.

FIGURE 20.—Trucks and troops well concealed in woods, but tracks at edge of wood draw attention and a stereoscopic study reveals all details. Photograph taken south of Ellaville, Ga., 22 Apr 40; scale 1:5,200.

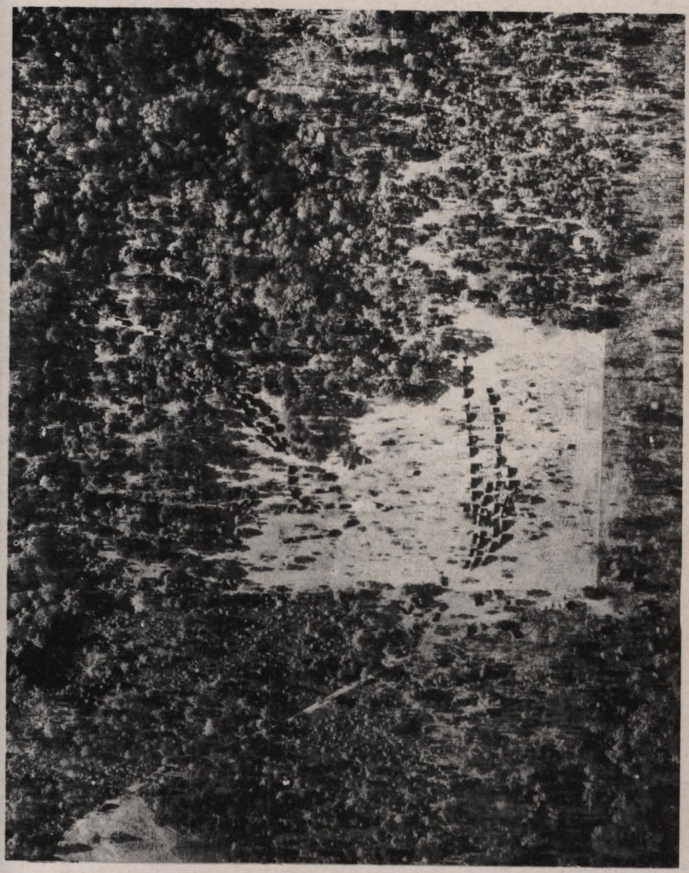

FIGURE 21.—Truck columns forming-up in the open. Photograp taken in the early morning; scale 1:5,200.

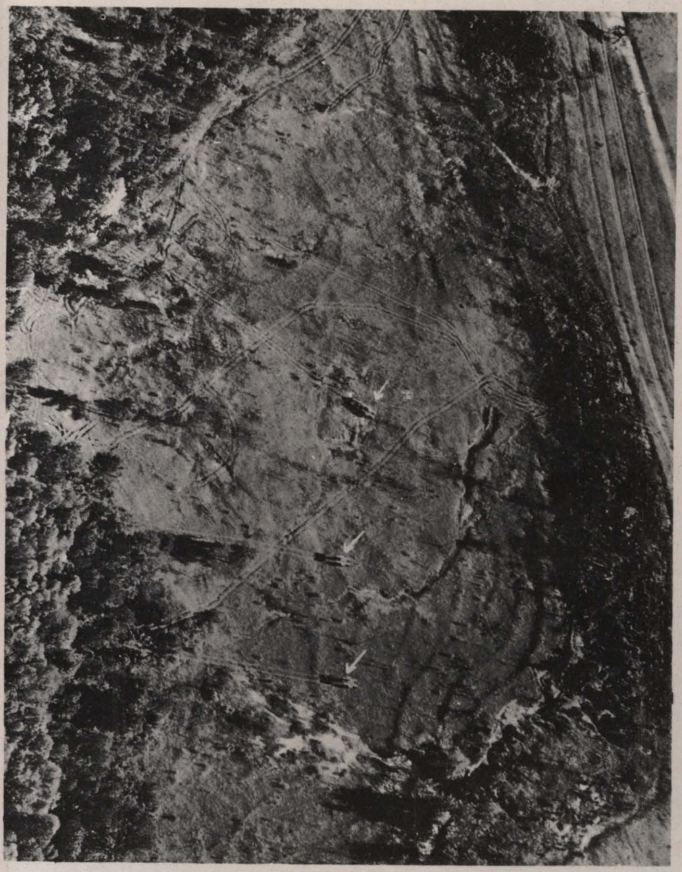

FIGURE 22.—Tank tracks in the vicinity of assembly areas and tanks moving from assembly area, Fort Benning, Ga.; scale 1:1,000.

FIGURE 23.—Numerous trails, paths, and tracks leading from main highways near Montfaucon show important troop activities. Photograph taken at 5,700 feet, 5 Mar 18.

FIGURE 24.—Briquenay village. If snow is on the ground, roads and trails in use show black.

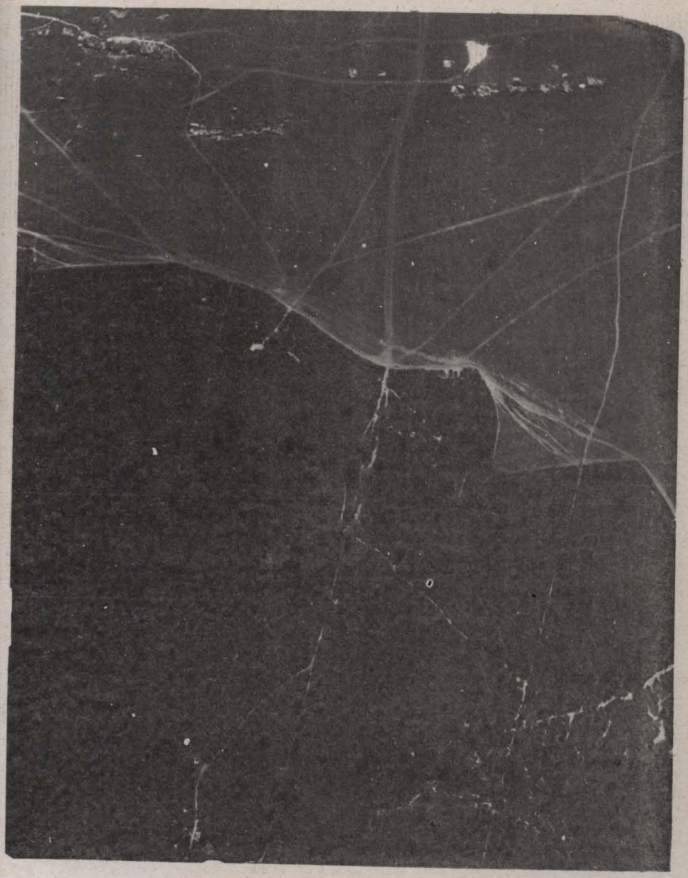

FIGURE 25.—Numerous paths and tracks leading into woods south east of Flirey, 2 Sept 18; scale 1: 6,900.

FIGURE 26.—Trenches and wire entanglement west of Rembercourt, 20 Sept 18; scale 1:6,700.

FIGURE 27.—German World War photograph. French and German positions along the Alger-Auberge road near Prunay. At points marked 1 can be seen wire entanglements and at 2 are to be seen passages through the wire.

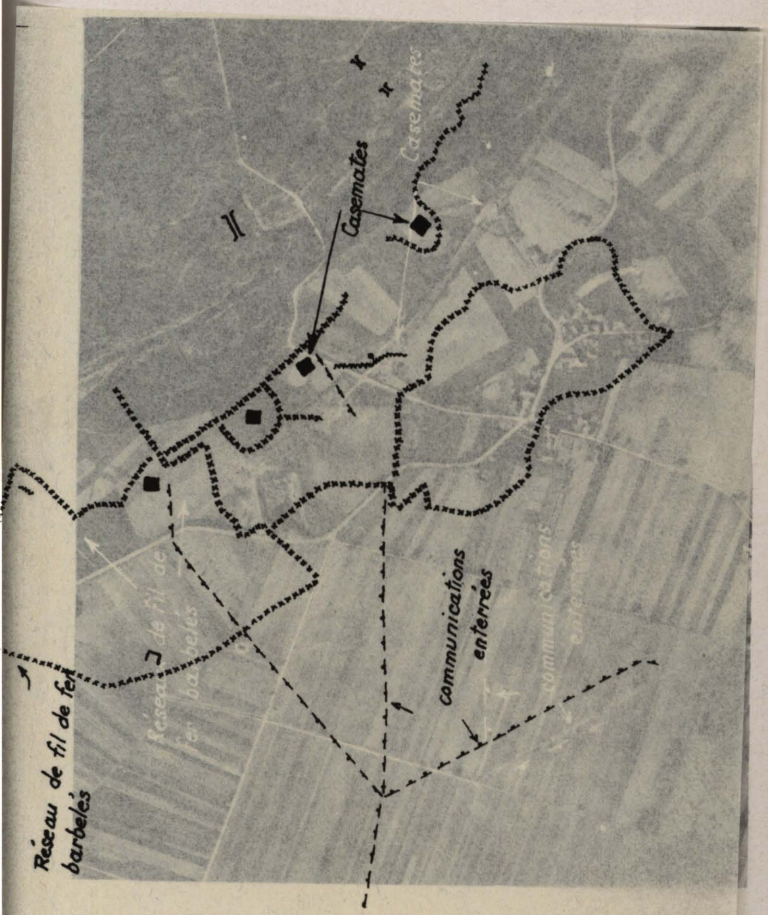

FIGURE 28.—German defenses east of the Rhine [illegible] lines of wire, casemates, and buried communi[illegible] 1:13,000.

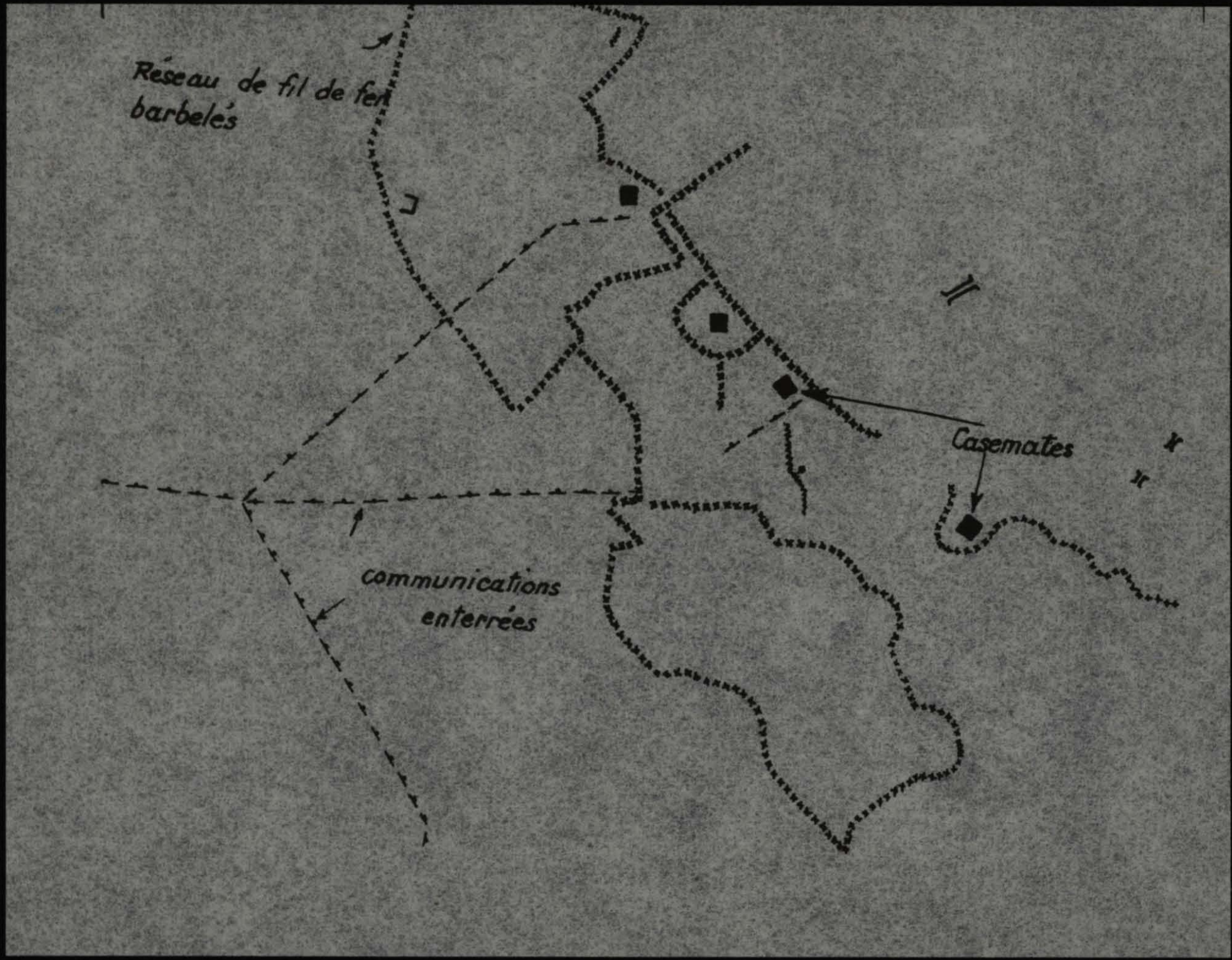
Réseau de fil de fer barbelés
Casemates
communications enterrées

FIGURE 28.—German defenses east of the Rhine, 2 Feb 40, showing lines of wire, casemates, and buried communication lines; scale 1:13,000.

FIGURE 29.—Breaches in wire made by artillery fire.

FIGURE 30.—Trenches and wire entanglement showing on photograph taken soon after snowfall.

FIGURE 31.—Listening posts as developed in the World War. At points marked 1 can be seen listening posts in round holes at the end of a communication trench; at 2 and 3 can be seen listening posts in haystacks.

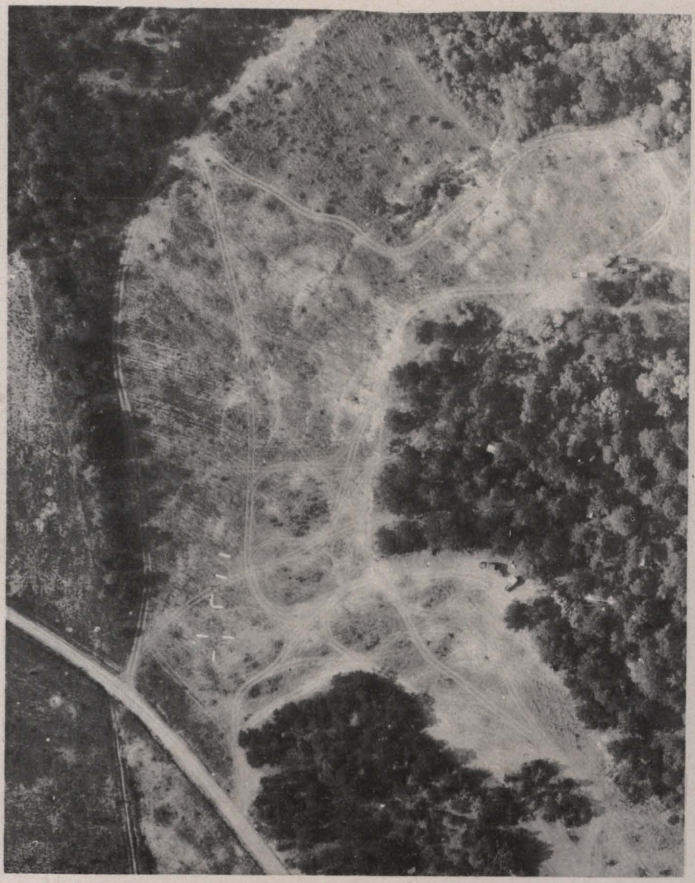

FIGURE 32.—Panels reveal the presence of a command post; tracks reveal the scope of activity in the area. Fort Benning, Ga., 25 Apr 40; scale 1: 2,500.

FIGURE 33.—Tank barriers at points marked A; tank mines along the line BB.

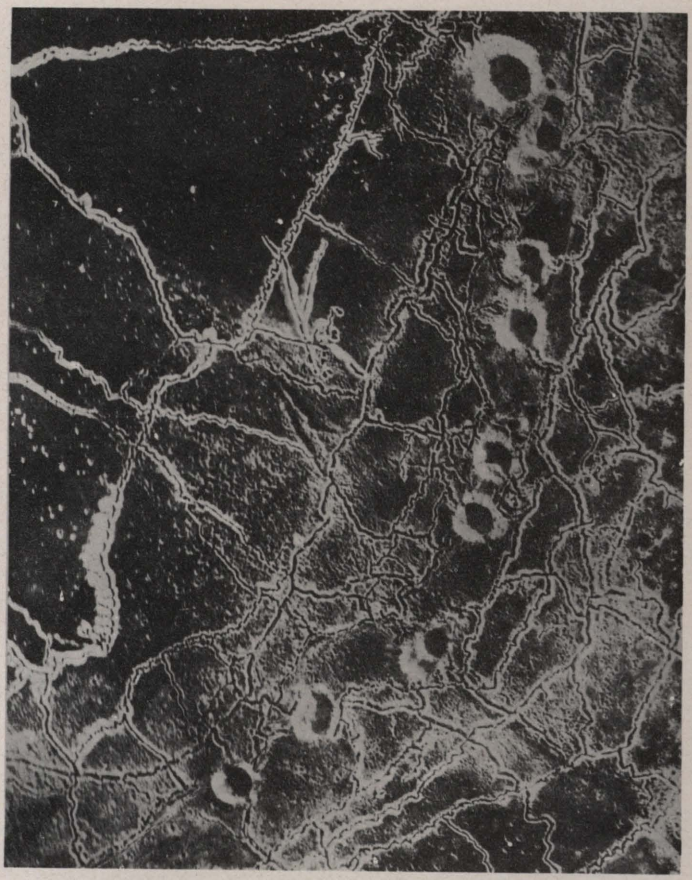

FIGURE 34.—Results of mining operations. Crater area near Corney due to both French and German mining operations.

FIGURE 35.—Bands of wire and concrete pill boxes under construction near La Chausee, 14 Sept 18; scale 1:9,000.

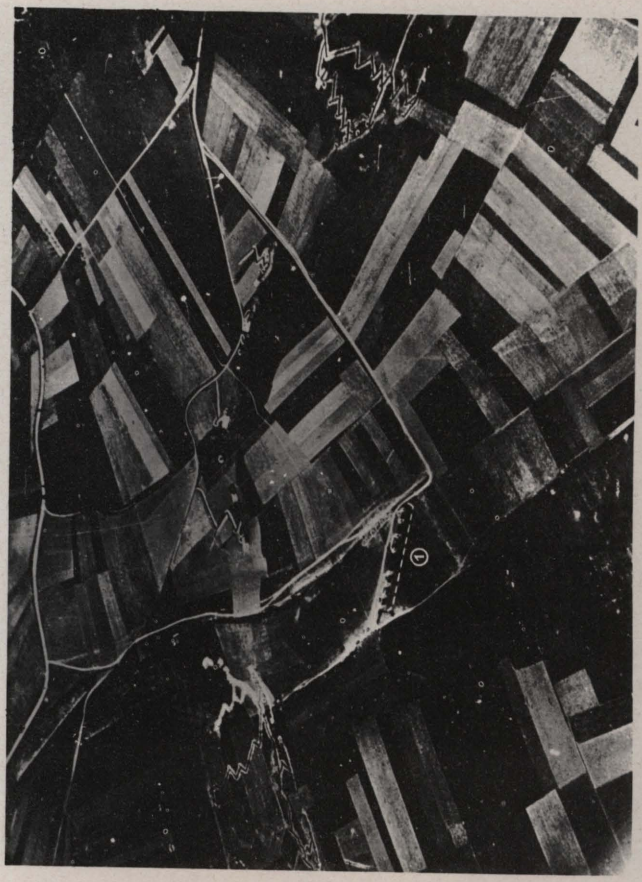

FIGURE 36.—German battery behind hedge at point marked 1. Tracks and openings in hedge are conspicuous.

FIGURE 37.—Camouflage batteries at points marked 2 and 3; trench leading to dugout at 5; narrow gage railway at 6; and patches where sod has been removed for camouflage purposes at 7.

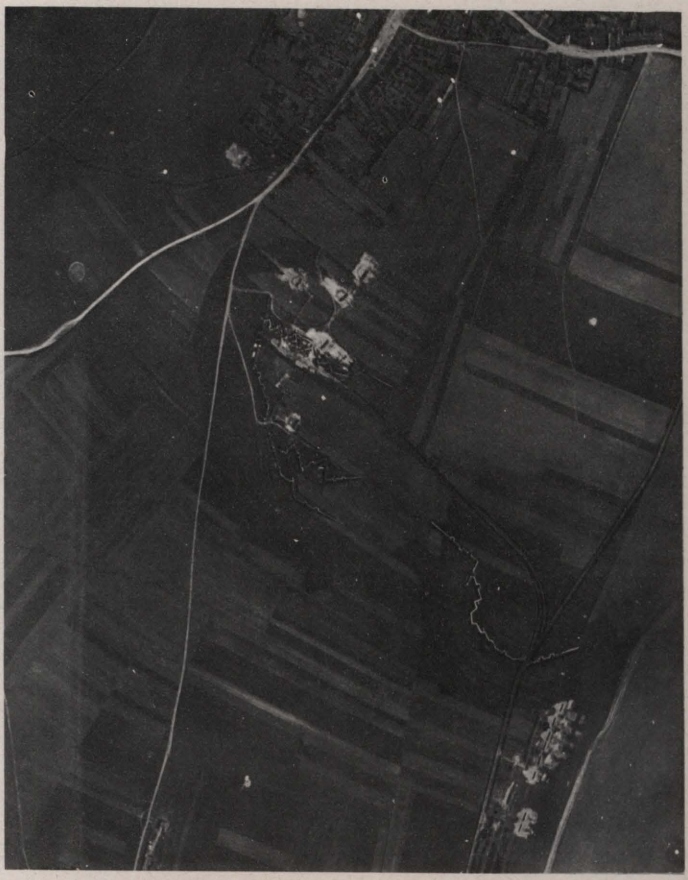

FIGURE 38.—Artillery battery position and strongpoint near Ornay, 15 Aug 18; scale 1:9,400.

FIGURE 39.—Photograph of battery positions taken soon after snowfall. At points marked 2 and 6 are blast marks revealing active guns in houses; at 3 are two inactive guns; at 4 are two active guns; and at 5 is a turn-around for vehicular traffic.

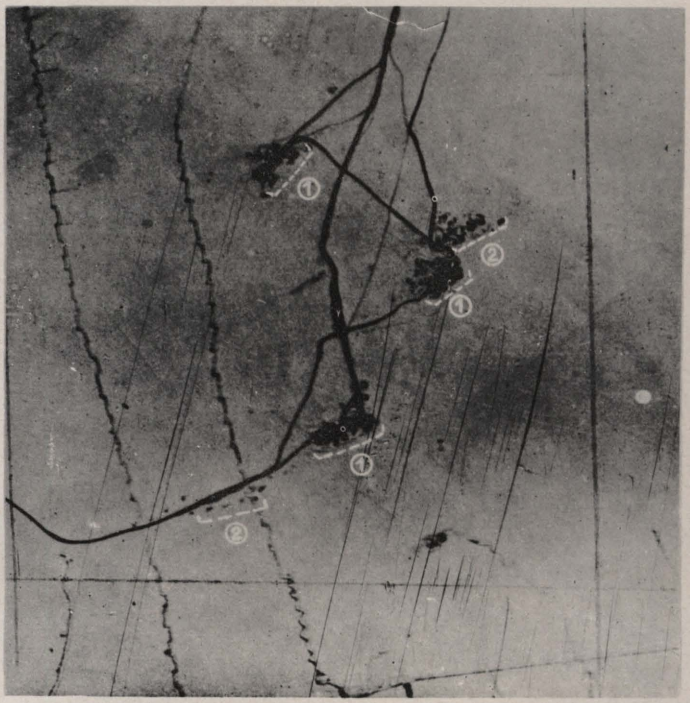

FIGURE 40.—Photograph of battery positions taken immediately after snowfall; occupied positions at points marked 1 and unoccupied positions at 2.

FIGURE 41.—Results of artillery fire upon a crossroad.

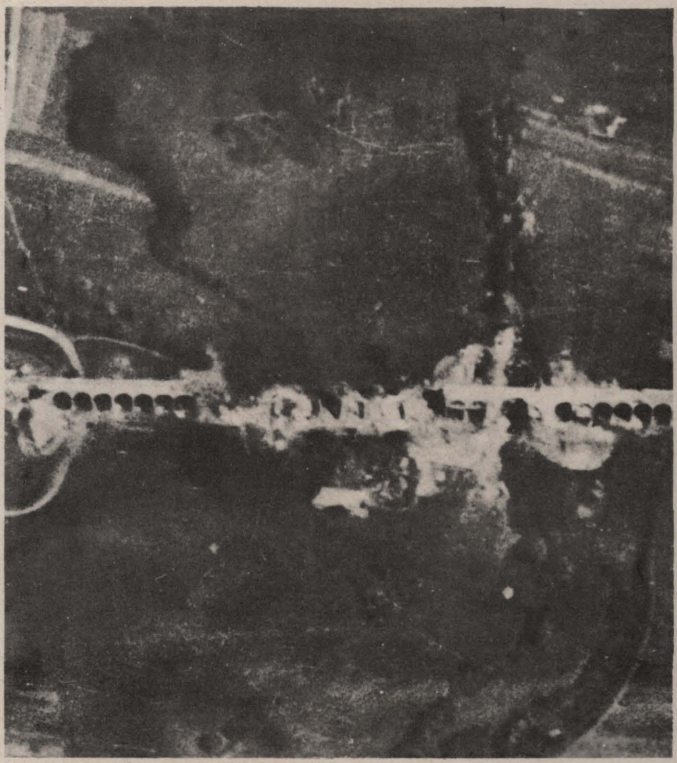

FIGURE 42.—Results of artillery bombardment of railway viaduct. The structure is demolished for a length of 300 feet.

FIGURE 43.—Billets, much used roads, and tracks

FIGURE 44.—Supply depot and hospital north of Chambley, 11 Aug 18; scale 1: 7,700.

FIGURE 45.—Ammunition dump along road near Thiacourt.
4 Sept 18; scale 1: 6,900.

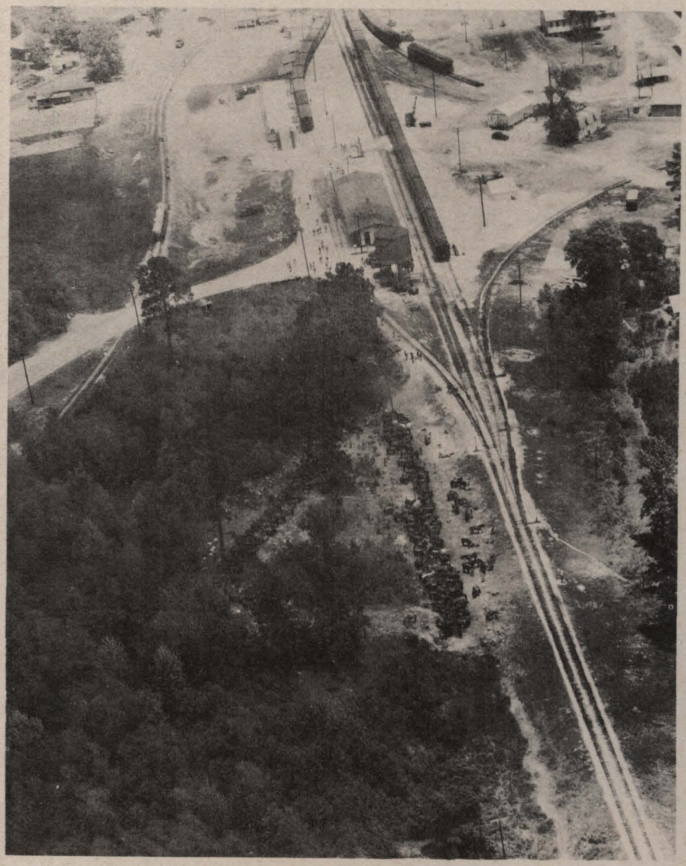

FIGURE 46.—Detraining point at Jasper, Tex., 26 Apr 40. Note faulty disposition of animals after detraining.

FIGURE 47.—British photograph showing salvo of ten bombs bursting on part of Dinant during the German advance in May 1940. Four bombs have struck the railway lines on the west bank of the Meuse, and two have struck the workshop on the opposite bank. A convoy of vehicles can be seen passing through Dinant on the Dinant-Liscogne road in the direction of a new ponton bridge.

FIGURE 48.—Ourches airdrome and paths.

FIGURE 49.—Showing a portion of the Ourches airdrome (fig. 48) as seen from an adjacent hill.

FIGURE 50.—Airfield southwest of Treves; French photograph taken 7 Apr 40. Scale 1:30,000. Stereoscopic study shows scattered airplanes on the airfield and antiaircraft artillery battery positions.

APPENDIX

LIST OF REFERENCES

Instructions relative to aerial photograph reading	FM 21–25; FM 21–26 (now published as TM 2180–5).
Regulations pertaining to aerial photography	FM 1–35
Measures for coordination of Engineer-Air Corps mapping team	FM 30–20
Instructions on camouflage	FM 5–20