MILITARY PHOTOGRAMMETRY IN ACTION IN EUROPE

Maj. J. W. Locke, C. of E., U. S. Army

DURING and since the recent war, many reports have been given concerning the mapping problems encountered and how they were solved; in general, these reports have covered the broader phases only. I intend to go into greater detail and present some of the detailed problems as encountered by a photo-mapping company in the European Theater of Operations.

It is the task of the photomapping company to put the various methods and instruments developed by the Engineer Board to use:— to make these methods produce maps in the field. As the commander of one of these companies, I was afforded the opportunity of closely observing the use of equipment developed by the Engineer Board, and I will attempt to describe the manner in which it was used.

My experience as a company commander began in May 1942 when I was given command of Company B, 30th Engineers, a photo-mapping company of a base topographic battalion stationed at Fort Belvoir. The equipment assigned to this unit consisted of twenty-eight bars of multiplex equipment, stereocomparagraphs, reflecting projectors and other auxiliary equipment normally required for topographic work. Our personnel consisted of nine officers and approximately 300 men.

In July of 1942 our designation was changed to Company B, 660th Engineers, and we became in fact a separate company, none of the remainder of the battalion having been formed. Shortly after this, we were shipped out of the country and arrived in England in September 1942. We were stationed in a large rambling one-story building in a suburb of London. (Fig. 1) This building contained many large rooms ideally suited for our purpose and individual booths for multiplex had been constructed, so our working conditions were rather good. Figure 2 shows one of our working rooms after we were in operation.

Of course, after arrival there was a wait of about two months before our mapping equipment arrived. To fill in this gap we requested a temporary loan of British equipment and received from them some drafting tables and stereoscopes.

We were then assigned our first task and, since this task occupied the majority of the comany until after the invasion of France, I will spend some time describing it. The job given to us was to prepare 1/25,000 maps of France. I was rather surprised at the enormity of the mapping requirements in France, having been under the erroneous assumption that France was well covered with maps. It seems that the only available large scale map coverage of France consisted of a 1/50,000 map with ten meter contours prepared at the time of Napoleon. These maps had originally been prepared at a scale of 1/80,000 with relief indicated by hachures. During World War I the British had blown these original maps up to a scale of 1/50,000 and interpreted contours from the hachures and spot heights. Thus, it can be seen that for all practical purposes our task consisted of producing a completely new map.

The basic materials supplied to us with which to produce these maps were sufficient to cause consternation to any upstanding photogrammetrist. I refer in particular to the photography. At this time no American planes were flying over the continent and the British had undertaken a photographic program for mapping Northwestern France. Their pictures were taken by 12 inch focal length cameras mounted in Spitfires. I will never forget the first flight map of this photography I saw. Having been accustomed to rejecting any flights that de-

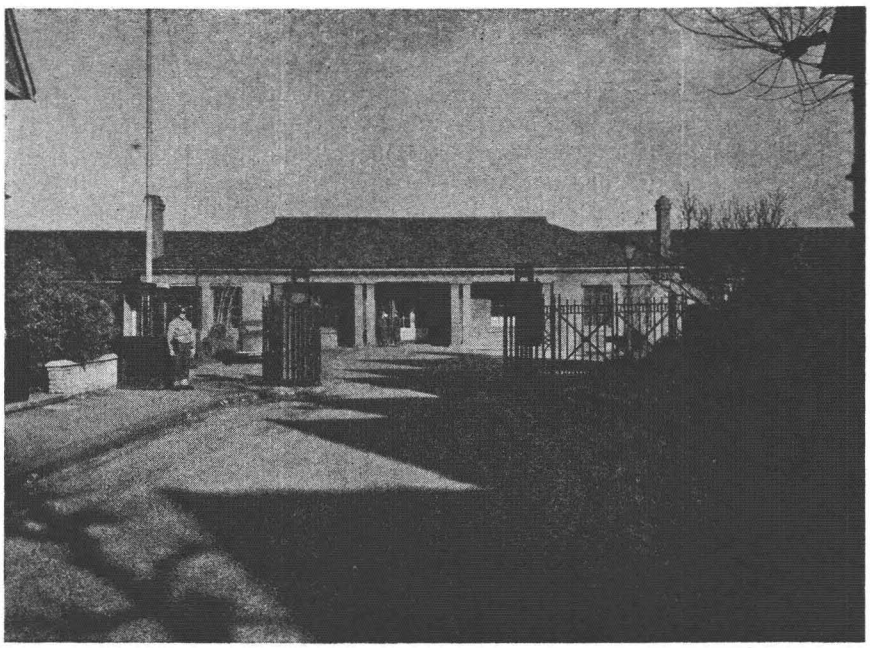

FIG. 1

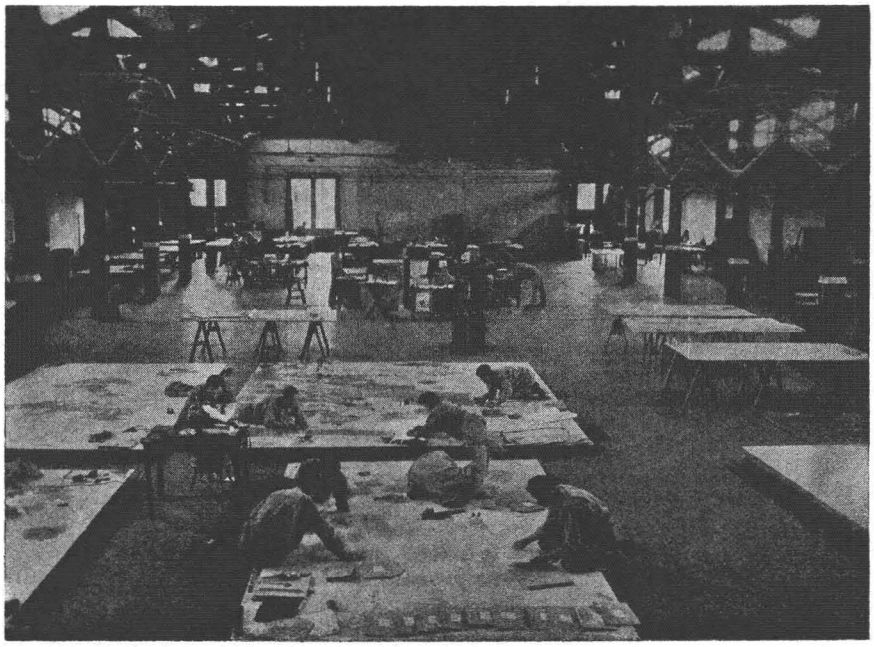

FIG. 2

parted from the 60% overlap and 20–30% side laps specifications of peacetime flying, this flight map came as rather a rude shock to me. Flight directions varied from 0°–360°, lengths from 1 to 100 pictures, and sidelap did not exist since seldom were two flights parallel. Many places were covered by 5 or 6 flights while innumerable triangular gaps existed throughout the area. These little gaps were particularly annoying as they generally seemed to contain a key control point. In justice to the R.A.F. I must explain that at this time the Germans held air superiority over France and it was exceedingly difficult and dangerous to fly at all, much less fly in a straight line at constant altitude. The procedure was to duck down through the clouds, get as many photographs as possible before the flak became too thick and then get out quickly. A great amount of credit is due the flyers for getting any photography at all.

The ground control supplied to us was not much better than the photography. This consisted of a list of triangulation points surveyed at the time of Napoleon. The list consisted of a short description, usually one or two words such as "Church steeple" or "Calvary" and a list of coordinates. These coordinates must have been copied and recopied very many times during their century and half of existence as we found many transcription errors of 100 or 1000 meters. About the only points we could identify on the photos were church steeples and quite often in the intervening time the old church may have been torn down and replaced with a new one a short distance away. Thus, you can see we had to proceed very cautiously in accepting a control point.

The type of map to be produced had already been designed by the British. For sake of uniformity, we adopted their style as it stood. They had reduced the map to as simple a state as possible while still maintaining legibility.

All roads were shown as solid lines either full or broken to reduce drafting work. The map was reproduced in 3 colors: black, blue, and brown. However, there was one point to which we objected. The British were showing all of the hedgerows for which Normandy is famous. These consisted of hedges from 5–10 ft. high which are represented by small black straight lines on the map. This mass of detail complicates the map and adds enormously to the labor of production. We felt that the time required putting in this detail might so slow down the work that we would be unable to complete the program in time. However, we mapped all of Normandy with the inclusion of this detail. Later on in the area just west of Paris the specifications were altered to eliminate the hedgerows in order to speed up the work. We were rather fortunate in this matter as the hedge-row fighting in Normandy and the Cherbourg peninsula is now a matter of history. The maps produced for that warfare were provided with the hedgerows and later when General Patton reached the area mapped without hedgerows, his only requirement was a road map.

With the basic material I have just outlined we set to work producing our maps in the fall of '42. Since our borrowed British equipment was very limited, we were reduced to fundamentals and started work using the radial line plot and hand compilation to compile planimetric detail. Work progressed very slowly by this method and we were very pleased to have our equipment arrive in November of '42.

However, we were immediately confronted with another problem. Our unit had been designed and trained to use the multiplex as its main mapping instrument with the stereocomparagraph as an auxiliary. We were well equipped with brand new wide angle multiplex straight from the factory but unfortunately the projectors and printer were designed for 6 in. focal length wide angle photography. We had no 6 in. photography. Our photography was 12 in. focal length

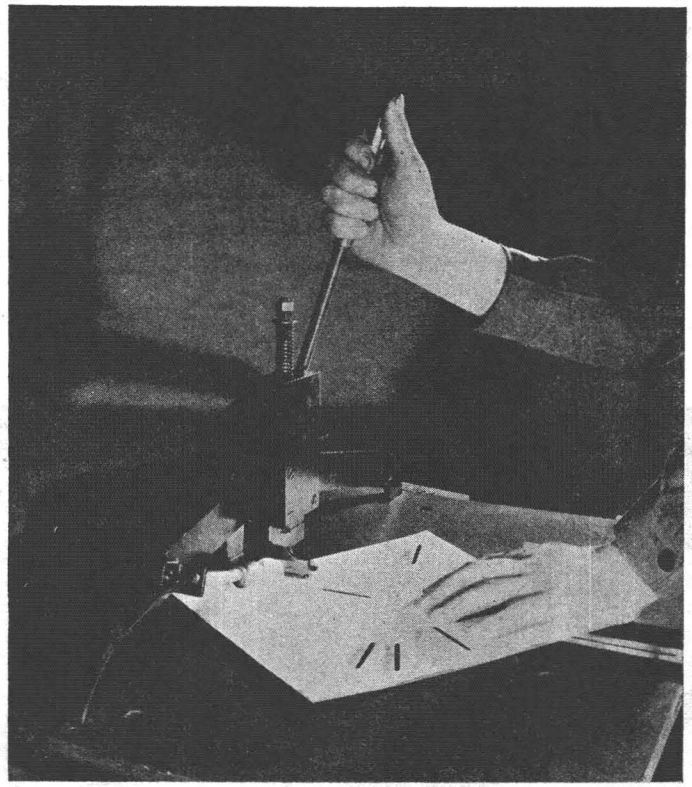

FIG. 3

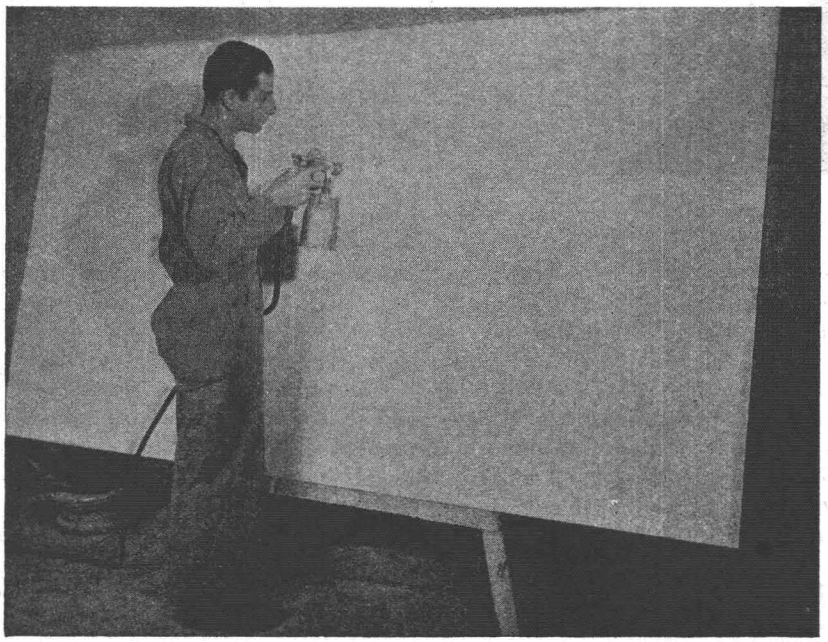

FIG. 4

which could not be used in our multiplex. Nor was it possible to construct a special printer for the job since the photography was 7″×9″ with the 7″ in the direction of flight and our equipment was designed for 9″×9″ photography. However, it was found after some experimentation that it would be possible to work individual pairs, providing sufficient horizontal and vertical control was provided for each model. Extension of control by multiplex was, of course, impossible. To provide the necessary horizontal control we relied on the slotted templet method. The Army at the time of our leaving the U.S. had only just adopted the slotted templet sets now issued to topo units and the equpiment had not been issued to our unit. Fortunately, before leaving the U.S. we had procured from the Engineer Board complete drawings of the set they were designing at that time. With these drawings we were able to procure a set from

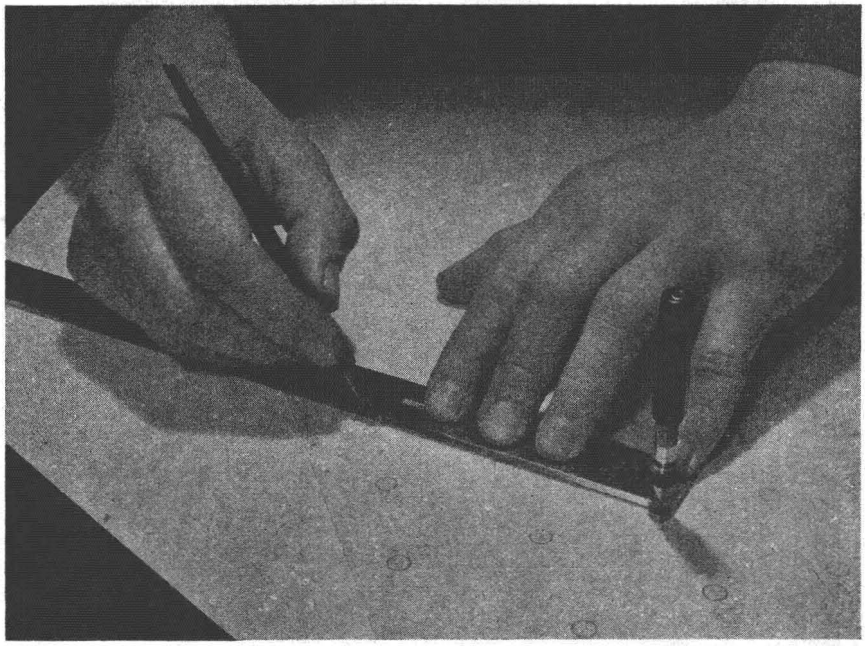

FIG. 5

British manufacturers in a short time. Figure 3 is the slot cutter of British manufacture which we used. Incidentally, the British, who had previously been relying on radial line methods for control extension at this time became quite interested in the slotted templet and procured several of these cutters.

Upon receipt of the slotted templet equipment, we used this method as a means of extending horizontal control sufficiently dense to set up our individual multiplex pairs. The method we found most successful was as follows: Our projection and control board was constructed of several 5′×9′ painted five-ply plywood boards mounted together. Figure 4 shows one of the boards being painted. We found this to be a fairly stable medium for our plotting. For templets we used a clear heavy acetate, .016 in. thick (Fig. 5). This material was sufficiently thick to resist buckling and at the same time had the obvious advantage of transparency. We found it very convenient to ray in our intermediate points on these templets before slotting them. In this manner the ray inter-

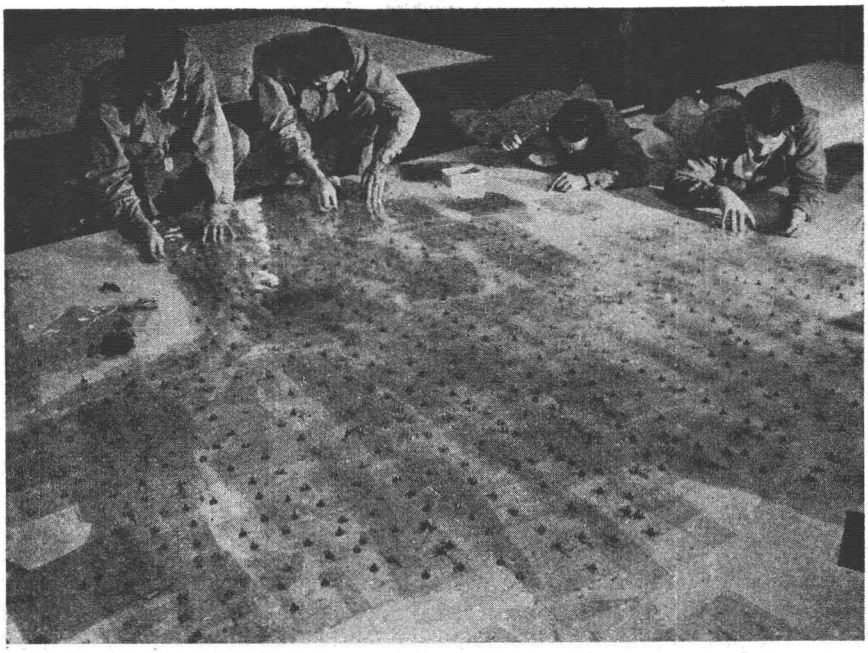

FIG. 6

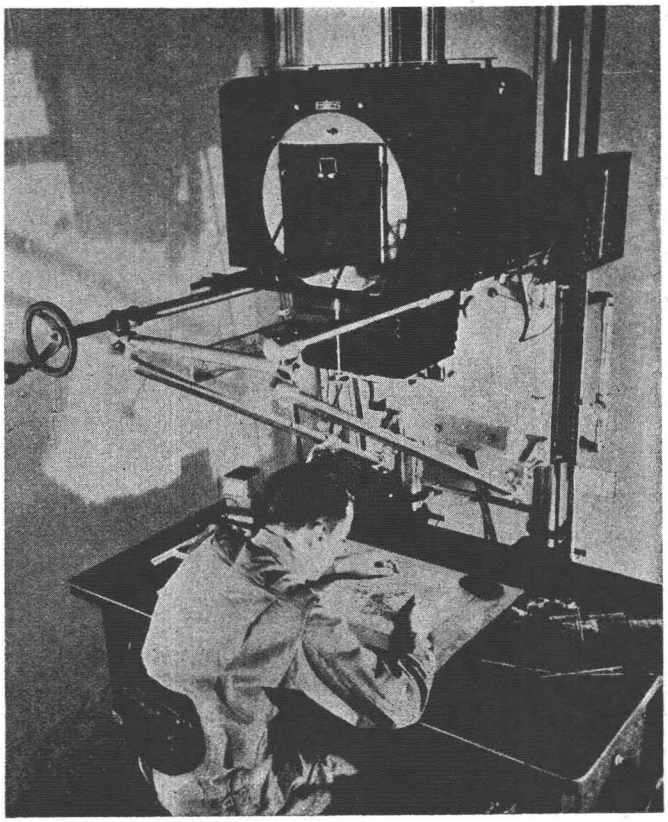

FIG. 7

sections showed up through the transparent templets when the plot was laid and we could mark the points with a small drill hole (Fig. 6).

While this method solved the problem of horizontal control. We were still lacking a means of vertical control extension. The British at this time were extending the rather sparse elevations given on the old French maps by means of stereocomparator measurements and arrangements were made for them to supply us with elevations for each pair of photographs by this method.

About this time our strength was increased by 100 men and in order to keep all personnel busy, we started using our vertical reflecting projectors, of which we had eight, for planimetry compilation (Fig. 7). The topography to accompany this compilation was provided by our stereocomparagraphs which we also kept busy.

Thus, you can see that our first maps lacked nothing in the variety of methods of production.—Horizontal control extension by slotted templets—vertical control extension by analytic methods—planimetric compilation by multiplex and reflecting projector—topographic compilation by multiplex and stereocomparagraph.

However, by the summer of 1943 our Air Force began to supply us with 6 in. focal length photography and we were able to use our multiplex as planned. Needless to say, our production increased considerably when this occurred.

While the production of 1/25,000 map was always the main task of the unit, many other jobs were undertaken. One of these was the production of photo-maps at a scale of 1/25,000. Due to the size of the area which required mapping, it was feared that the task might not be completed before our troops went ashore, and in order to assure some type of a map being available, the decision was made to cover the area as soon as possible with photo-maps which could be produced much more rapidly than the regular line maps. A large part of this job was assigned to our unit.

The photo-maps thus made were controlled by a slotted templet plot similar to that previously described. Since the photographs contained large amounts of tilt, rectification was necessary to obtain the accuracy required. The unit did not have any type of a rectifying camera, but a horizontal rectifying camera in use by one of our commercial aerial survey companies was obtained and shipped to us. This company also provided two technicians who spent several months with us instructing in the use of the instrument. The photographs were rectified and mounted to fit the control plot, detail was intensified and the resultant mosaics reproduced. A large part of Northwestern France was covered with this type of map whose quality varied greatly due mainly to the variation in quality of the available photography.

Another task assigned to the unit consisted of the production of large scale plots of proposed air field sites. In planning the invasion the Engineers had been assigned the task of preparing temporary landing strips on the continent for aerial support of our troops. These strips had to be ready for use within forty-eight hours after the troops landed. To do this, it was necessary to select the sites carefully, as only a limited amount of ground could be graded in this time, and to estimate the amount of dirt to be moved a rather accurate map of the area was needed. This problem was solved by producing 1/10,000 plots of each site using multiplex. The photography was taken at 12,000 feet altitude by R.A.F. planes equipped with 6 in. focal length cameras. For the most part, each airfield site was covered by one sortie. Control consisted of trig points, map points taken from existing maps, and water surfaces. Over 200 of these individual plots were produced.

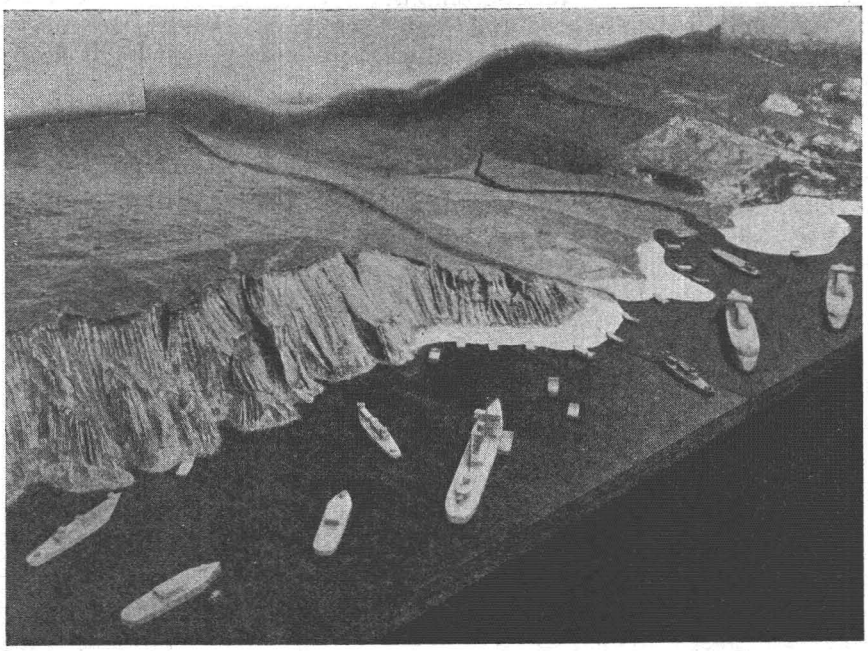

FIG. 8

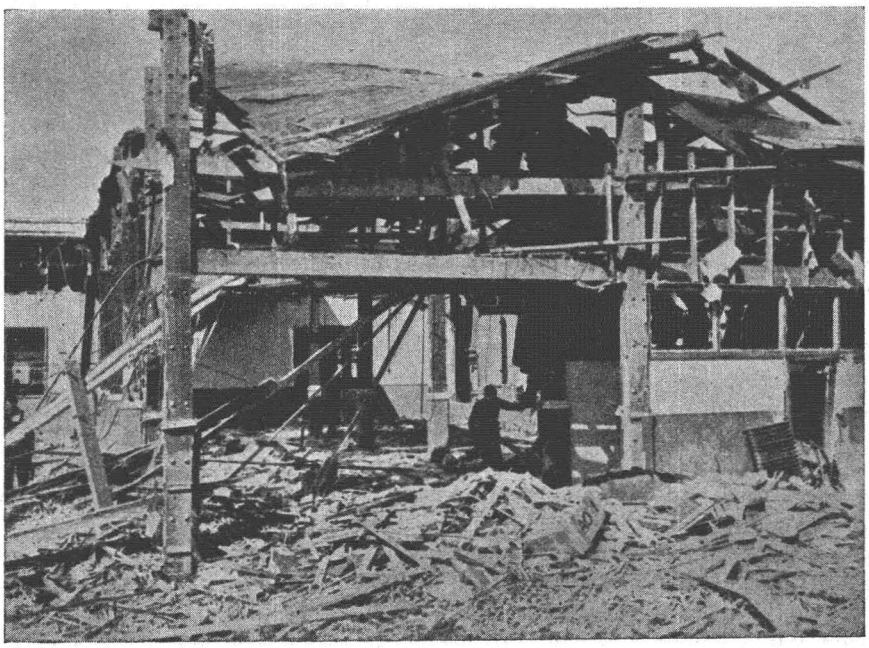

FIG. 9

One other miscellaneous task accomplished by the unit was model-making. Figure 8 is a training model produced by the company. The boats were also built by us. However, this task was eventually taken over by model-making teams assigned to the theatre.

A question many ask is: "How accurate were the maps produced under these conditions?" Naturally, one would not expect them to meet peace-time specifications, but our own artillery found them to be sufficiently accurate to fire from. The Germans also considered them to be quite good. Although, they had

FIG. 10

occupied France for four years and had produced maps of their own along the coast of Normandy, we captured, in the campaign of Western France, copies of our maps of the Cherbourg peninsula which the Germans were using. These maps had previously been captured by the Germans, the German grid and marginal data superimposed on the sheet, and the maps then issued to their troops.

Although not a combat unit and always stationed well behind the zone of fighting, our unit was not fortunate enough to come through the war unscathed. The V-1 bomb took its toll. Compare Figures 9, 10 and 11,—our billets after receiving a direct hit by a V-1 with Figure 1. Fortunately the bomb fell very early on a Sunday morning and landed in that part of the building used for office space rather than the barracks or working space. This fact minimized casualties which otherwise might have been tremendous. The company was back at work in the rear part of the building within three days.

I have dwelt mainly on the operations of Company B, 660th Engineers previous to the invasion of France, since shortly before that event I left the organization for another assignment. However, the mapping task of this unit continued in London and later in Paris right up to V-E day. I feel that great credit is due

this unit, the many other topo units and the various civilian agencies back here in the States who all aided in the tremendous task of providing maps for the defeat of Germany.

It is my opinion that this war has provided further proof of the great need for accurate topographic maps in any military operation. The increase in mobility of modern weapons demands improvement in the methods of map making to obtain greater rates of production. The great variety of modern weapons requires a variety of maps and charts as never before. All of these factors place a

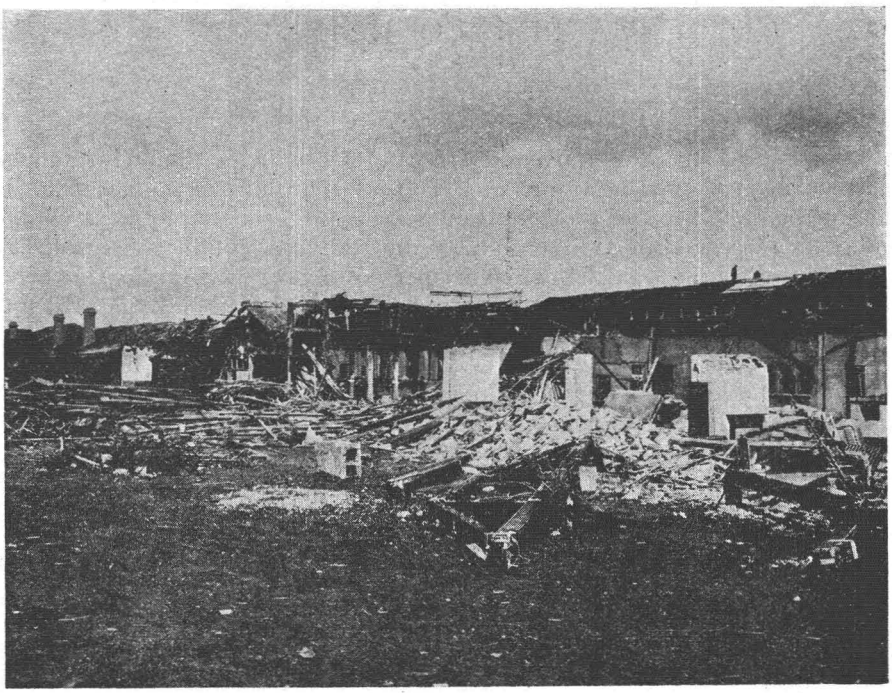

FIG. 11

greater burden upon the map maker. To enable him to assume this burden and keep mapping methods apace with scientific development in other fields, it is essential that research work of the type carried on by the Engineer Board be continued with the impetus it has assumed during the war years.