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Air main with Victaulic Joints slung on two steel cables across the gorge of the Hikonese River, Japan. View shows a 200-ft. span of 8-in. line.

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2,250—1.9.42.

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LONDON'S LARGEST CRATER.

By LIEUT.-COL. J. P. HAUGH, F.S.I., M.I.M.&CY.E., R.E.

DURING an air-raid on the evening of Saturday, 11th January, 1941, a bomb of unknown calibre fell in the centre of the open space at the junction of Lombard Street, King William Street, Queen Victoria Street, Princes Street, Poultry, Threadneedle Street and Cornhill.

This open space, like many of London's more important street junctions, had long since been undermined by the enterprising engineers of the London Passenger Transport Board and the apparently solid road surface was in effect a roof, consisting of approximately 2′3″ of mass concrete filling on steel troughing carried on a framework of steel girders and columns and covering the ticket office, escalator head, subways, etc., of the Bank Tube Station.

The bomb appears to have fallen in the centre of the road in front of the Royal Exchange, penetrated the concrete and troughing and exploded on impact with the floor of the booking hall near the top of the escalators. The concussion effect of the explosion in the confined space of the booking hall and adjoining subways lifted and shattered the entire roof, which fell back into the cavity forming a crater 1,800 sq. ft. in area, 150 ft. long and from 10-30 ft. deep, partly filled by the collapsed roof in the form of a twisted chaos of girders, steel troughing and blocks of concrete.

Some months prior to this incident a Royal Engineer organization consisting of a number of General Construction Companies had been set up in London to assist the civil authorities in the restoration of London's vital services damaged by enemy action, a task which during the heavy and sustained raids of the autumn of 1940, had proved too heavy for the civilian resources then available. The essence of the liaison between the civil and military engineers was that the military authorities placed their resources in skilled manpower and plant at the disposal of the civil authorities to be used where they could render best service to the community, with the one stipulation that the jobs allocated were to be really worth-while engineering undertakings as distinct from mere clearance work requiring no specialized knowledge in supervision or execution.

During the first weeks of this combined civil and military effort it was possibly with some misgivings that those responsible for the public utility undertakings of the world's greatest City handed over some of their cherished and now bombed property to the care of the "Military." However, as the R.E. Units demonstrated with practical results their enthusiasm and skill, doubts rapidly gave way to frequently expressed appreciation and confidence in the

troops' ability to set about a job in the shortest possible time, confidence which was typified in the action of the Chief Engineer to the City of London who, after the incident on the 11th January, faced with London's largest crater at the hub of one of the busiest traffic centres in the Metropolis, walked into the Company Office of 691 General Construction Company at 10.30 hours the following morning and told the O.C. that the job was his.

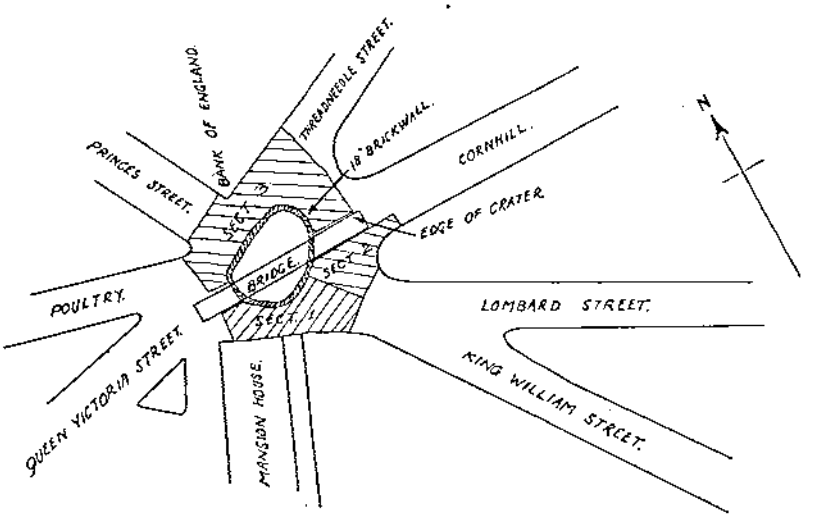
Flexibility of military resources was then well demonstrated in that one and a half hours later 40 Sappers and 260 Pioneers with the assistance of 5 Cranes, 25 lorries (5 working with each crane), one D.8 Bulldozer, 12 Compressors (later increased to 19), 6 Oxy-Acetylene Cutters, were busy breaking up and clearing away the wreckage.

During the following 13 working days 2,713 tons of concrete, 225 tons of steel troughing and 131 tons of girders were hauled out of the crater and cleared away. An average of 236 tons per day.

In dealing with large lumps of concrete considerable assistance was rendered by 2 Sappers from a New Zealand Forestry Company using New Zealand Timber Jacks, a tool which although very simple in construction appears to be new to this country. These men worked together, first one taking a bite under a suitable projection on a large block of concrete with his jack, lifting it a few inches and holding it while the second took the weight at a lower point and so on until the block was in a position for a chain sling to be passed under it and removal from the crater effected by means of a crane. The results obtained with the New Zealand Timber Jack on this and other bombed sites have been so successful that the Civil Defence Authorities have arranged for a number to be made in this country for the use of Rescue Squads.

When the primary duty of rescue work, location and removal of casualties had been carried out, consideration was given to the most expeditious way of restoring traffic facilities, both in the streets above where seven routes were blocked and as regards the Tube below, where although trains were still running through the station, access to the platform from the street was impossible.

From consideration of the site, in conjunction with other bomb damage in the vicinity, it was apparent that facilities for West to East traffic were of vital importance and, if they could be provided by some temporary expedient, should not wait until the crater was cleared and a permanent road way constructed. After consultation with the Police, the City Engineer and the London Passenger Transport Board, it was decided to place a temporary bridge to carry traffic from Queen Victoria Street and Poultry to Cornhill. A strip of road approximately 20' wide could then be permanently constructed around the edge of the crater and, by means of a modified round-about traffic system, would permit access to and from all the



DIAGRAMATIC PLAN SHOWING BRIDGE AND RECONSTRUCTED AREAS.

FIG 1

streets converging at the crater. The bridge could then be removed and the centre of the crater made good. (Figure 1.)

The choice of bridge was governed by the following factors :—

(*a*) Clear span of gap—156'.

(*b*) Due to the position of escalator shafts and lift shafts, there was only one spot, approximately a third of the way across the gap, with a foundation sufficiently sound to carry an intermediate pier.

(*c*) The bridge must be capable of carrying 12½ tons L.P.T.B. buses, preferably with no spacing restrictions.

(*d*) The nature of the approaches (roofs of subsidiary subways) offered little opportunity for counter-sinking the ends of the girders.

To avoid excessive approach ramps, depth of superstructure must be small.

(*e*) Bridge to be erected quickly by Sappers who, although second to none as civil engineers, had little or no training in the use of special R.E. Field Engineering bridging sets.

(*f*) If a standard military bridge were to be used it must be a type that the War Office could make available immediately. The best solution appeared to be a four girder large box-girder bridge in two spans with intermediate pier consisting of a standard light railway bridge trestle, and this was duly delivered in 29 railway wagons. The total length of the

bridge was 164', the girders for the spans being 50' 6" and 113' 6" respectively. The bridge seats were of the orthodox baulk timber construction and a temporary 1½" wood surfacing was laid on top of the chesses to protect them from wear and tear of traffic.

However, in consequence of the difficulty of providing reliable anchorages for derricks, winches, etc., and the availability of suitable cranes, it was neither convenient nor desirable to adhere to regular field practice in the assembling and launching of the girders.

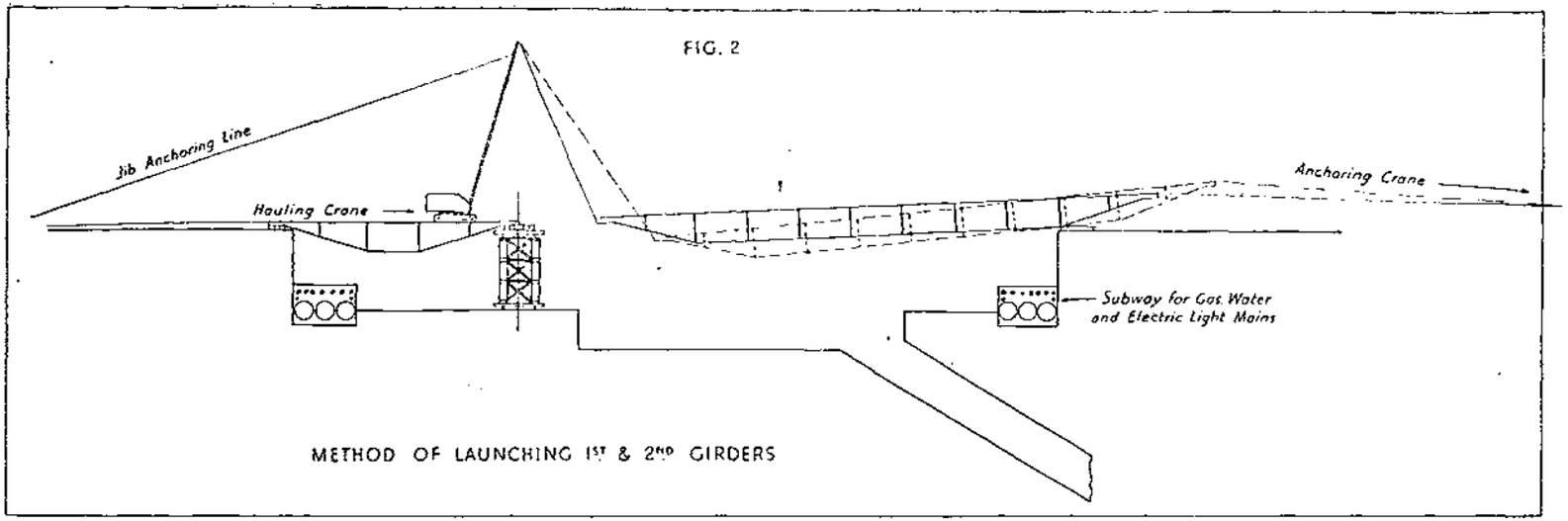
While the unit Trestle Pier was being erected all the girders were completely assembled in the streets adjoining the gap, the 50' 6" girders in Queen Victoria Street (West side of gap) and the 113' 6" girders in Cornhill (East side). The short girders were then lifted bodily by crane and placed in position on a short span decked down complete. The long span girders were pushed by man power, assisted by a bulldozer at the rear end, up to the edge of the gap, swung into line of the bridge by crane and launched by the hauling and preventor tackle method. The hauling equipment consisted of a crane (35' jib) standing on the pier with its jib up to the minimum practical working radius of 10'. (Figure 2.) The preventer equipment, in the absence of convenient orthodox anchorages, was provided by the dead weight of a Caterpillar Crane standing in line of bridge, about 100' back from launching rollers, tight against the wall of the Royal Exchange and with its cable passed through a snatch block secured to the under-carriage about 4' from the ground.

From calculations it appeared that the maximum stress in the hauling cable would just fail to overturn the crane standing on the trestle. Consequently to allow for uneven hauling or other unforeseen sources of extra stress the cable was slung from the top of the jib and anchored back to a piece of heavy plant in the rear. Incidentally, this additional precaution also served to reassure the crane driver, who was unshakeably convinced that without it he and his crane would topple into the crater. Actually, due to skilful driving on the part of both crane drivers, the girders rolled into position very smoothly and the extra guy was not called upon to avert disaster. The final two girders were launched in the usual manner by rolling them out on top of the first pair.

The long span was then decked down and the ramps completed in hardcore, with tar macadam surfacing, the whole job from the bedding of the trestle to painting the ribands taking four and a half days. (Figure 3.)

The whole of the operation had been watched with no little interest from Mansion House, and the Lord Mayor was the first civilian to cross the bridge, after which he declared it open and shaking hands with some of the officers and men said, " I thank you on behalf of

FIG. 2



METHOD OF LAUNCHING 1ST & 2ND GIRDERS

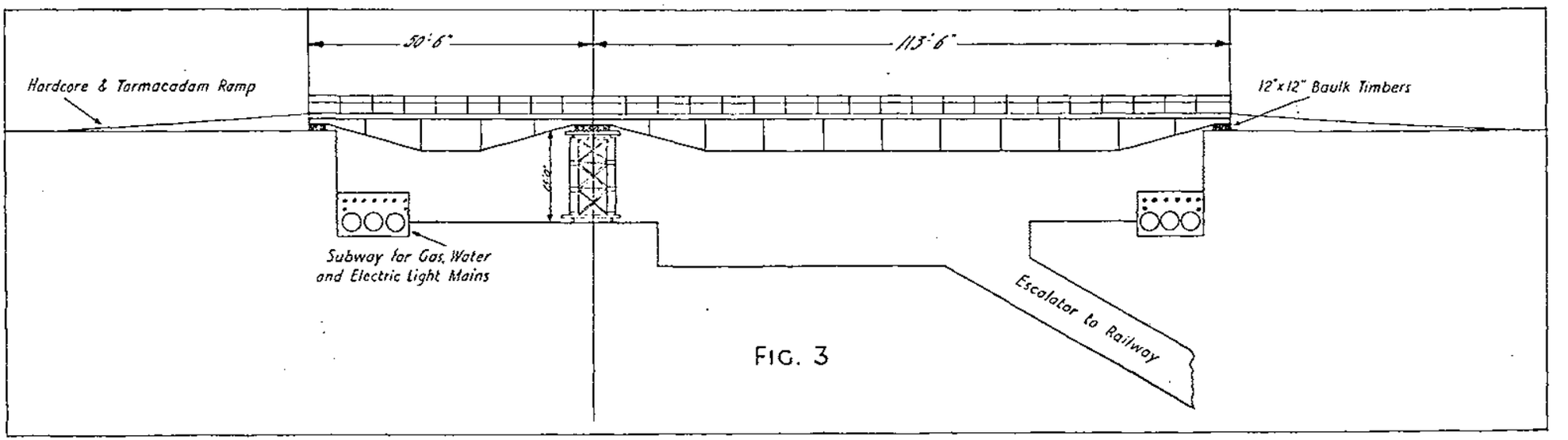


FIG. 3

the citizens of London. You have shown magnificent spirit, the spirit that is going to win the war. I thank you all, both officers and men alike."

Figures supplied by the London Passenger Transport Board indicate that during the seven weeks the bridge was in use 39,520 buses passed over, together with, according to the City Police, 158,000 other vehicles.

Concurrently with the construction of the bridge and later stages of debris clearance, work was proceeding on the new carriage way around the edge of the crater. At approximately 20′ from the edge of the crater the booking hall floor steps down four feet or more towards the centre. An 18″ brick wall was built on top of this step and the gap between the wall and the crater edge spanned by such steel troughing as could be recovered in a usable condition from the crater. Concrete filling and tar macadam surfacing completed the running surface.

The first section completed, Queen Victoria Street to King William Street, was opened to traffic seven days after the opening of the bridge. Completion of the links connecting Queen Victoria Street and Poultry with Princes Street and Threadneedle Street (Sections 2 and 3) enabled sufficient traffic to flow around the perimeter of the crater to permit dismantling of the bridge.

On the north side of the crater the 18″ brick wall ran within 15′ of the Bank of England and to obtain a 20′ carriageway, a troughing construction was replaced by a concrete raft carried on 24″×7½″ ×25′ R.S.J's at 10′ centres. The R.S.J's were anchored into the existing Bank wall and cantilevered over the new 18″ wall giving about 5 feet overhang.

With the effective diameter of the crater considerably reduced by the construction of the perimeter carriageways, the removal of the bridge girders presented little difficulty, complicated only by the L.P.T.B. having constructed close beneath and alongside the bridge an efficient but rather fragile temporary corrugated-iron subway leading to the escalator shafts. However, cranes were placed on the south side of the crater and the girders lifted out piecemeal and carried away without any damage to the temporary subway.

Removal of the bridge was commenced at 08.00 hours on a Sunday morning and by 18.00 hours on the same day the whole structure, including approach ramps, had been cleared away from the site. During this period traffic proceeded along the North side of the crater unhindered.

The gaps in the perimeter carriageway at the bridge abutments were made good during the following few days and this marked the completion of the R.E. contribution to the work of reconstruction. The job had now reached a stage where traffic facilities between all the streets converging on the junction were adequate, the subways

and escalators sufficiently cleared to permit access to the platforms and any further reconstruction to be carried out could not be regarded as of urgent importance in the interests of the national effort. Consequently, in accordance with the policy which has guided all Royal Engineer assistance to Local Authorities in London, the troops were withdrawn to carry out reconstruction of greater public utility in the neighbourhood and the L.P.T.B. left to carry on with their own Contractors any additional works they thought desirable.

*THE AUSTRO-GERMAN PASSAGE OF THE DANUBE AND SAVE, 7th-17th OCTOBER, 1915.**

(With Map.)

By BRIG.-GENERAL SIR JAMES E. EDMONDS, C.B., C.M.G., D.LITT., *p.s.c.*†.

THE Danube and its tributary the Save, which enters it from the west just above Belgrade, guard the northern frontier of Serbia; and the Drina, a tributary of the Save, serves the same purpose for the western frontier.

The success of the Austro-German campaign against Serbia in the autumn of 1915, in order to bring aid to the hard-pressed Turks in the Gallipoli Peninsula, depended on the passage of the northern water-line. Special reason for haste, apart from Turkish need, existed; for by a Convention made by Germany with Bulgaria on the 6th September, Tzar Ferdinand had agreed to join the Central Powers provided they broke into Serbia before thirty days had passed. As so often, strategy had to give way to tactical and technical considerations. Falkenhayn was at the time engaged in driving back the Russians into the interior of their vast country; but this campaign, he has told us, could be stopped at any moment if the Gallipoli situation demanded it, when he would switch his operations, drive a route through northern Serbia and thus be in a position to send aid to his Turkish Allies. It may be assumed, therefore, that from the 25th April onwards Falkenhayn had a campaign against Serbia in mind and had made at least "intellectual preparations" for it, as had been the case as regards Belgium and France before August, 1914.

The final reconnaissances were undertaken at the beginning of September under Colonel Hentsch (of Marne fame), who was planning the details of the campaign, and he took with him a colonel of artillery and a colonel of engineers. The collection of bridging equipment was not facilitated by the fact that after their second defeat by the Serbs in December, 1914, the Austrians had sunk or damaged all the boats and barges in the frontier rivers, and had destroyed bridges, including the great railway bridge over the Save near Belgrade on the

* Derived mainly from the *German Official History*: *Der Weltkrieg*, 1914-1918, *Volume IX*, the *Austrian Official History*, *Osterreich-Ungarns letzter Krieg*, 1914-18, *Volume III*, and *Das Ehrenbuch der deutschen Pioniere*, quoted as *The German Engineers Book of Honour*, which gives a number of details.

Vienna and Constantinople route, and the railway floating bridge at Semendria. Plenty of vessels were available on the upper reaches of the Danube, and about a hundred steamers and 500 barges were collected ; but these could not be brought down as long as Belgrade was in the enemy's hands and the mines in the river had not been cleared ; and so could not be counted on for the passage of the rivers. A number of harbour launches and motor boats were therefore brought from Hamburg by rail.

The fact that the Austrians had six 600-ton barges and two landing stages hidden behind the island of Semendria, and an equal number behind a small island north of Temesziget, and a steamer at the former place and another lower down the river at Moldava island (the officer who brought it up in the night of the 2nd-3rd October got an Iron Cross), had much influence on the choice of the points of passage.

The two rivers were formidable obstacles, both in width and depth in the reaches which were in question. The Save is from 330 to 770 yards wide, and the Danube below Belgrade is on the average double that width. The current of the Danube averages 4.80 feet a second and is 6.80 in flood, that of the Save is somewhat more rapid. Further, when the *Kosava*, an E.S.E. wind, blows, as it does in autumn, the Danube becomes a rough sea, bridging with military equipment is impossible as the waves fill the pontoons with water, and even the steamers have to abandon movement. Only special pontoons and barges with high free-board, and heavy anchors and mooring chains are of any use in the Middle Danube.

In both rivers the islands which belonged to Serbia were occupied by her forces, but only a few of them would be of any use to help a crossing. They were low-lying, covered with bush and generally marshy or dotted with ponds of water. The Serbian bank of both rivers is precipitous except in the Macva (the area in the eastern angle between the Save and the Drina which enters it at right angles from the south 40 miles above Kupinovo on the western side of the attached map) and in the Morava valley, whilst the Hungarian or northern bank is flat and low-lying except on the east, where the outlying spurs of the Carpathian Mountains appear.

These conditions made concealment difficult, hampered all the preparations, and later interfered with the observation and the effect of artillery fire. The railways in the area, except the main Vienna-Semlin-Constantinople route, were single lines, and the roads in such bad condition, with many bridges broken in order to hinder invasion, that three German road-building companies and 22 Austrian Labour battalions had to be sent to put them into order for the transport of the heavy artillery, and immense quantities of road metal and planks brought to site.

The Serbian positions were fixed by air reconnaissance ; but this gave no clue as to how strongly they were held.

The Austro-German forces available, organized as Mackensen's Group of Armies, with Major-General von Seeckt as Chief of the General Staff, consisted, from right to left, of :

The Austrian Third Army, under General von Kövess :

Austrian 62nd Division	11	battalions,	6	batteries.
Austrian L. of C. Troops	21	,,	11	,,
Austrian XIX Corps	33	,,	29	,,
German XXII Reserve Corps	35	,,	47	,,
Austrian VIII Corps	31	,,	43	,,

German Eleventh Army, under General von Gallwitz :

German III Corps	21	battalions,	36½	batteries.
German IV Reserve Corps	27	,,	37	,,
German X Reserve Corps	18	,,	4½	,,
Austrian Frontier Guard	8	,,	9	,,

Danube Flotilla : 9 armoured monitors with 49 guns and 20 other vessels.

The artillery available for the bombardment comprised for the Austrian Third Army, 470 guns, of which about one-third were heavy and super-heavy ; for the III Corps, 11 heavy and super-heavy batteries ; for the IV Reserve Corps, 6 ; and for the X Reserve Corps, 40 batteries, of which 12 were heavy and 2½ super-heavy ; all in addition to the divisional artillery. The batteries were sited on arcs, so that their fire converged on the points of passage.*

The Serbian Army, under Prince Alexander, with Voivode Putnik as Chief of the Staff, was organized into three Armies, respectively, of 3 divisions, 2 divisions and a cavalry division, and 2 divisions, and Army Group Timok of 2 divisions, with 2 divisions in general reserve ; the divisions were particularly weak in artillery, some having 9 batteries, but five of them only three. The total of heavy guns was only 65, all of old patterns.

It was known that about half the 240 battalions on the Danube front (of the total of 288) had been taken to face the Bulgars on the eastern frontier, for Bulgaria had mobilized on the 25th September, although she did not declare war on Serbia until the 14th October.

To sum up, according to the *German Official History :* 180 Austrian and German battalions, with 900 guns, were about to attack 120 battalions and 330 guns, and opposite Belgrade the general proportion was 3 to 1.

The most suitable places for a passage seemed to be two re-entrants, one on the Save immediately above Belgrade, and the other on the Danube opposite the bend of the river at Ram. Artillery fire

* Maps 17 and 18 in the *German Official Account, Volume IX*, give their positions.

could be concentrated from two sides on the enemy's salient position. Belgrade itself was to be attacked, as facilities existed for transporting troops across there in steam-ferries. Between Belgrade and Ram conditions were not so favourable. For the IV Reserve Corps, above Ram, the approach marches across marshes and meadows to the crossing-places over the northern branch of the Danube to reach Temesziget Island would be extraordinarily difficult; and the preparations for them had been much delayed by the weather as well as by the enemy.

The bridging material in possession of the different corps varied in quantity and description:

	Engineer Companies	Large steamers and Motor Boats	Length of Bridging Material Metres
Austrian XIX	9	3 steamers	11,000
German XXXI. R.	6		900
Austrian VIII	6	12 steamers	33,500
German III	7	1 steamer 6 motor boats	8,000
German IV. R.	7	7 motor boats	5,400
German X. R.	6	1 steamer 8 motor boats	5,000

This table, taken from the *German Official History*, does not quite agree with the details for the Eleventh Army given in the *Engineers Book of Honour*, which are:

III Corps: 6 engineer companies, 8 bridging trains. 12 four-part pontoons (Austrian), 4 motor boats, 1 steamer*, 6 Danube barges,* 2 landing stages.

IV Res. Corps: 7 engineer companies, 10 bridging trains, 13 four-part pontoons, 4 motor boats, 1 harbour launch and 70 fortress pontoons.

X Res. Corps: 7 engineer companies, 7 bridging trains, 4 motor boats, 1 steamer, 6 Danube 600-ton barges, 2 landing stages.

The X Reserve Corps had also a German Engineer Landing Company with 8 steam launches, 12 horse boats (each of which would carry 2 field guns and 12 horses), and 16 landing boats (each carrying 30 men).

For the eventual bridging the Austrians provided material for three heavy bridges, each about 4,000 feet long, one of the Herbert

* In calm weather a steamer could tow 3 Danube barges and thus transport 3,000 infantry, or 3 field batteries with teams, or 50 horsed army wagons, or 24 motor lorries.

type, one of the Danube type, and one of a lighter type transportable by train (on seven trains) called the Save bridge. The Herbert bridge has been described in an earlier article, " The German Passage of the Danube, 1916," in *The R.E. Journal* for March, 1941. The Danube bridge, with a double roadway, was formed of 600-ton barges with wooden superstructure. The Save bridge was built of the Austrian service seven-part steel pontoons, with wooden superstructure.

It will be noticed that more bridging material was allotted to the sector above Belgrade than to that below, although in the latter sector the river was wider. The allotment to the XXII Reserve Corps was far the smallest. No improvement in this distribution could be expected until the crossing could be made at Belgrade, and the course of the Danube below the town opened to navigation.

It was Mackensen's intention that the passages of the Austrian Third Army near Belgrade and that of the X Reserve Corps at Ram should take place on an earlier date than those of the German III and IV Reserve Corps which lay between them. One reason for this echelon in time was that the attacks at Belgrade and Ram would probably draw the Serbian forces towards these places, and this would not only make it easier for the III and IV Reserve Corps to cross, but also would make it possible to deliver a decisive thrust into the Morava valley with more effect.

In the operation orders of the 4th October the Austrian Third Army was, early on the 6th October, regardless of difficulties, to make a diversion attack with the 62nd Division from Visegard on the western frontier across the Drina, whilst the twenty-one battalions of L. of C. Troops attacked the Macva on both sides. The rest of the Third Army and the German X Reserve Corps, on the flanks of the projected crossings, were to begin shooting for effect in the afternoon of the 6th, and be assembled at dawn on the 7th :

—Austrian XIX Corps, the main body at Kupinovo (about 25 miles above Belgrade), the rest at Boljevci (9 miles below Kupinovo) ;

—the German XXII Reserve Corps against Zigeuner island, just above Belgrade, held by the enemy ; and

—the Austrian VIII Corps against Belgrade itself.

The III and IV Reserve Corps were to begin shooting for effect on the 7th : the former was to cross on the 8th before daylight, and the latter, as it had a very difficult task, at the earliest on that date.

Both armies began artillery registration on the 5th October with air and balloon observation, fire being also opened at other than the selected crossing-places as a measure of diversion. Neither the German nor the Austrian accounts mention any action of the air forces except for reconnaissance and artillery ranging.

AUSTRIAN THIRD ARMY.

On the Drina front, the Austrian 62nd Division, having no heavy artillery, failed in its attempt to cross the Morava, the first parties being driven back by fire. The operation was postponed to the 8th, and then abandoned. The L. of C. battalions crossed on either side of the Macva, but then met with stout resistance, and were unable to extend the small bridgeheads they had secured. Their opponent was the Serbian Danube Division II, which was thus detained in this sector. A demonstration with artillery and infantry fire was also carried out by Austrian *Landsturm* troops at Orsova, 40 miles below Ram, who later, on the 22nd October, crossed the river. These diversions, it will be observed, were carried out by second class troops.

On the main front of the Austrian Third Army, the wide and partly marshy depression on the north bank of the Save was destitute of cover, so very few batteries could be placed there, and the range was nearly everywhere 5,500 yards or more when fire was opened at midday on the 6th. The enemy did not reply except to the diversion fire of the 26th Division directed against Ostruznica, between the projected crossing-places of the XIX and XXII Reserve Corps. The Serbs did not even fire at a dummy monitor moored opposite Belgrade, in order, it was thought, not to disclose their battery positions, many of the guns, in fact, being hidden in houses. There was no certainty that their batteries had been located, for the co-operation of the air force and the artillery in those days was in its early stages. The effect of the bombardment was indicated only by fires and by the destruction of such of the enemy's defence works as were visible.

Under the cover of darkness the assault troops were led from their cantonments, many of them very far back, to the crossing-places. The route of the XXII Reserve Corps was along clay embankments with narrow wooden bridges, as the Austrians had inundated the area of the lower Save, and the water had not been entirely cleared off. To traverse the soft ground took longer than expected, and the 44th Reserve Division, in particular, was late. In the VIII Corps, of which only the 59th Division was to cross, the troops were for the most part brought down stream by steamers to the islands and the bank opposite Belgrade.

At 2.30 a.m. on the 7th very heavy fire was opened on the landing places, range was lengthened after ten minutes, and then in light rain the crossing began.

To begin on the west: against the express wish of the German High Command*, but with the consent of the Army commander, the

* Accounts vary: the *Engineers Book of Honour* says "against the express wish of the German higher leaders"; the *Austrian Official History*, "against direct orders" (but does not say whose); the *German Official History* says, "with the consent of the Army commander."

G.O.C. XIX Corps decided for tactical reasons to cross, not at Kupinovo, but farther east, at Progar, where, as also at Boljevci, it would be easy to get a footing on a salient presented by a bend of the Save. Supported by two monitors, the passage was achieved without serious fighting, although some of the troops were as much as 90 minutes late. Here and at most other places, with the help of the current, the advanced parties were rowed over by the engineers in pontoons, ten infantrymen to a boat ; the second echelon came over in tows ; and as soon as landing piers could be erected, ferry boats were used, as described in the previous article on the Crossing of the Danube in 1916.

Against the XXII Reserve Corps the Serbs had guns and machine-guns in action, and the passage of its divisions proved costly : 40 of the 60 pontoons were hit and sunk and many men drowned. The 44th Reserve Division managed to get one battalion over before daylight to the south bank of the Save immediately above Zigeuner (" Zig " on the map) island, which was still occupied by the Serbs, and had two footbridges to the southern shore, and another battalion got ashore on the western part of the island itself. The 43rd Reserve Division landed 1½ battalions at the eastern end of the island ; but the Serbs held out in the rest of it, and fought stoutly in spite of gun-fire from the monitors. An attempt to seize the small island which lies to the north-west of Zigeuner and flanked it, and was connected to the northern bank by a causeway, completely failed, although supported by gun and trench mortar fire ; but the attack was repeated in the afternoon with success. Attempts to send troops over the river by daylight were abandoned.

The passage of the troops of the VIII Corps caused the greatest anxiety. The flames of burning houses in Belgrade and searchlights illuminated the water which they had to cross until the night seemed almost as clear as day. The observers looked long in vain for the signal which was to be given as soon as the troops had landed. At last, about 4 a.m., a long procession of pontoons was seen passing south of the small island which lies due north of Belgrade, slowly rowing to the Serbian shore below the fortress. The Serbs also saw it. Almost immediately searchlights were turned on and the pontoons were overwhelmed with fire. Some of them sank ; others drifted unguided down stream. Nevertheless about 2,500 men succeeded in landing just below Belgrade and reaching the railway embankment on a 4,000-yard front, where, supported by the monitors, which diverted much of the Serbian fire, they hung on, having indeed little choice in the matter.

During the night of the 7th-8th each division of the XXII Reserve Corps succeeded in ferrying over 2½ battalions more. Two battalions of the 44th Reserve Division, sweeping down the bank of the Danube, cleared the way for their comrades and the battalions of the 43rd

Reserve Division on Zigeuner island, which, with its two footbridges, fell into German hands.

The VIII Corps, too, sent over portions of the two mountain brigades; so that on the morning of the 8th some twenty-seven Austro-Hungarian companies stood on the northern edge of Belgrade. The Serbs were not strong enough to throw them into the river, although their fire, in spite of renewed German bombardment, prevented any reinforcements crossing by day. Meantime, battalions of the 44th Reserve Division had attacked the western outskirts of Belgrade, and parties of the VIII Corps, assisted by the fire of two monitors, fought their way into the north-eastern quarter of the city.

When night fell on the 8th the Serbian gunfire ceased and throughout the night the engineers ferried troops across the Danube: the remainder of the XXII Reserve Corps, except a portion of the 43rd Reserve Division, and all the rest of the 59th Division. Soon after midnight the Serbian commander ordered his infantry back to the line Vracat—Ostruznica, on the hills overlooking Belgrade on the south-east, and about 6 a.m. on the 9th the Austro-German troops entered the city unopposed. As they had to wait for guns and ammunition, a pause took place, but the construction of bridges over the Save was begun.

GERMAN ELEVENTH ARMY.

The Ram salient bend of the Danube, against which the attack of the German X Reserve Corps was directed, is hilly and overlooks for a long distance the flat land to the north and west; and from the Goricaberg, nearly a thousand feet high, the ground falls steeply to the Danube, here on the average 1,100 yards wide. The German batteries were placed on the west, north and east of the salient, most of them in the hilly ground on the northern bank just east of Ram.

The first objective was the Goricaberg, and to gain it the 103rd Division was to be put over early on the morning of the 7th. Its water transport was concealed in the mouths of the Nera and the Karas and behind a small island between them. The 101st was to cross in the evening farther east at Bazias, where the pontoons were hidden in the "winter harbour." As the Serbs had been forced off their positions on the Goricaberg by the convergent German artillery fire, the passage of the advanced guard of the 103rd Division, in patrol boats, succeeded almost without loss. Field-Marshal von Mackensen and General von Gallwitz, who were at the command post of the X Reserve Corps, agreed with the proposal of its commander, that the resistance being so very slight the 101st Division should begin to cross at once, and this operation was carried out without difficulty. After a little fighting, the X Reserve Corps had by evening gained possession of the Goricaberg, and in all 14 battalions and

several mountain batteries had been transported over the river.

The IV Reserve Corps had not, according to the programme, to cross until the 8th October. It had many difficulties to contend with, as both Temesziget island and the northern shore for a long distance were overlooked by the heights on the southern shore, 350 feet above them, and it was not easy to give artillery support for the crossing. Nevertheless, by the 7th, the infantry and engineers of both divisions had been carried to Temesziget island. In view of the unexpectedly easy success of the X Reserve Corps, it was decided, about midday, to begin crossing at 3 p.m., after a short artillery preparation. Some of the infantry did not receive the order in time, and the attempt was made with fewer pontoons than planned. The Serbs spotted the movement and opened fire. Only the 105th Division succeeded in putting any men across, and then no more than 1½ companies, to the southern shore near the estuary of the Mlava, and this small party was soon engaged in a desperate fight for two factory buildings held as strong-points, with only long-range artillery support.

The 11th Bavarian Division stuck to its carefully worked out scheme and did not attempt to send any men across until the morning of the 8th, when a three hours' bombardment, beginning at 6 a.m. was to be fired. But a " mistake " was made about the starting signal, and embarkation began after half an hour's fire, and it happened the Serbs were more or less surprised. They opened " somewhat heavy fire," but the Germans were able to land and to push on to Petka and form a small bridgehead. Meantime, the 105th Division had sent over more troops, and by 10 a.m. had captured the two factories, and then pushed on to the heights beyond, so that the crossing seemed to have been made secure. The reserve division, the 107th, was brought up and transported to Temesziget island. The X Reserve Corps in the course of the day drove weak Serbian forces off the Ram heights and brought over more men, though Serbian long-range fire occasioned many stoppages.

A change of zero hour had also been made in the III Corps. Instead of starting on the morning of the 9th, it began crossing on the night of the 8th-9th. Conditions were difficult, as the shore west of Semendria was nearly 650 feet above the water. It had been arranged that the mass of the corps should therefore pass by the eastern end of Semendria island. After a personal reconnaissance the corps commander, at the last moment, decided that the whole of the 25th Reserve Division should cross above the western end of the island, so that it could attack the old walled town of Semendria from the west.* The change brought nothing but trouble. According to the *German Official History* the sudden fall of the water level uncovered

* The railway line running south from Semendria is the western limit of the hilly country; east of it is the flat valley watered by the Morava, and by the Mlava and the Jezova on either side of it.

a sand-bank and made a long detour necessary* and day broke before any boats had landed. As a result of Serbian fire only eight of the 53 pontoons with 150 infantrymen arrived on the southern bank west of Semendria, and the pontoons could not return for more men. Meantime, the passage of the first echelon of the 6th Division, east of the island, had been effected in the darkness without incident by means of a steamer towing three Danube barges, and by 6.30 a.m. three battalions, all of the same regiment, had been got ashore east of Semendria, had driven the weak enemy away and captured two guns. The steamer returned for three other barges which meantime had been loaded, and continued the process, bringing empty barges back, so by midday, thanks to the fog† and the steamer not being hit, the whole of the infantry and five batteries of the division had been landed, and they pushed out quickly to enlarge the bridgehead. In view of this success, the G.O.C. III Corps decided to stop any attempt to land west of Semendria island, and to pass the 25th Reserve Division over the river behind the 6th Division. By the evening therefore, the whole corps was united east of Semendria on the south bank, and at night the detachment which had been landed west of the town was withdrawn.

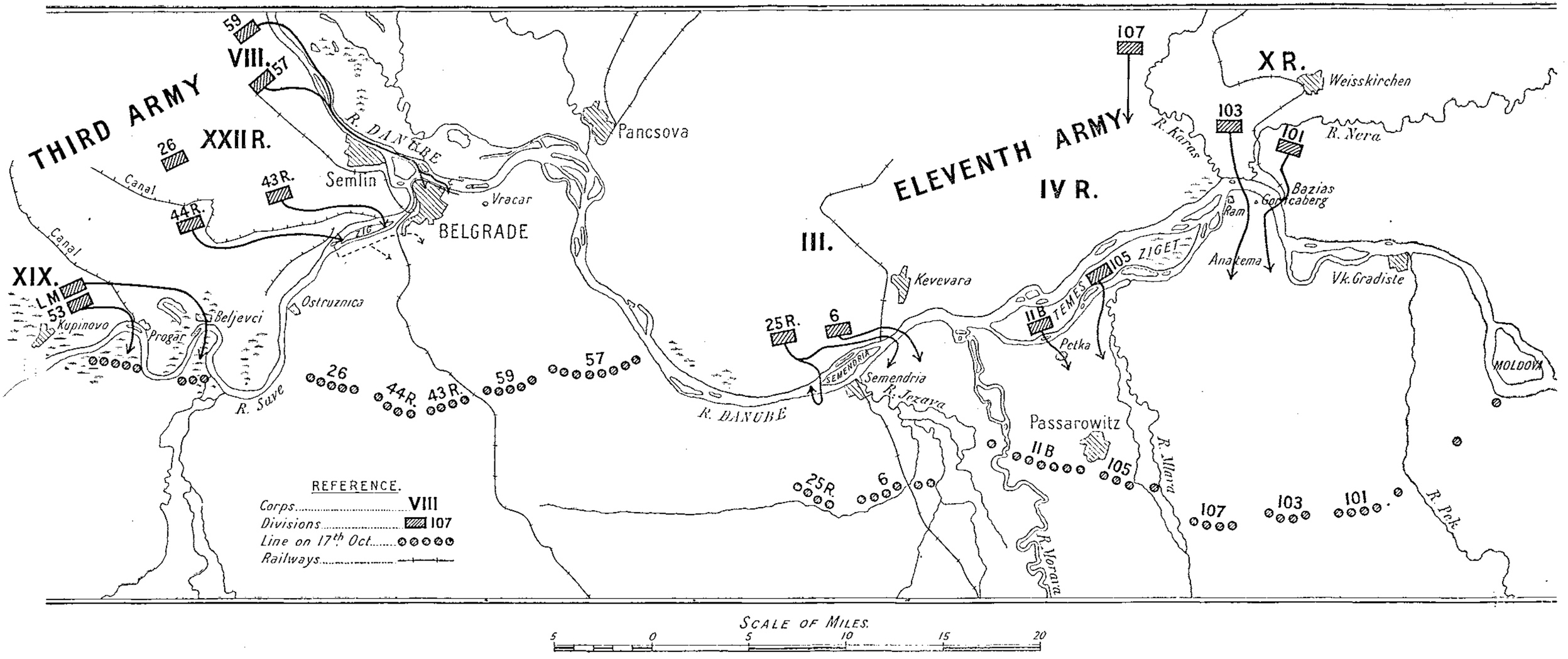
The IV Reserve Corps had to abandon its projected attack on account of fog; but when visibility improved the 105th and 11th Bavarian Divisions advanced to a line about two miles from the Danube, although the high Indian corn greatly hampered tactics. One battalion of the 107th Division was brought to the south bank. The X Reserve Corps was also held up by fog; but in the evening advanced to the Anatema ridge and secured the chord of the Ram peninsula. The Eleventh Army had thus acquired three small bridgeheads, and the Third Army one larger one at Belgrade.

Bridge building was now taken in hand. By the 10th a pontoon bridge had been built from Zigeuner island, and by the 14th a second, fit for heavy traffic; others had been constructed at Pragar and Boljevci, and by the 14th the VIII Corps had built one between Semlin and Belgrade. On the 12th, however, the dreaded *Kosava* began to blow and communication was interrupted on the lower Danube; only two steamers and the vessels of the German Engineer Landing Company could face it, and no other steamers could get past Belgrade from the upper Danube until the 16th. Each corps then received two steamers, each with three barges. The Eleventh Army could not begin bridge building until the 18th October, on account of

* The Austrian account, however, says that the Danube was swollen by the heavy rain and flowing strongly, and that the current had not been allowed for. This is confirmed by the *Engineers Book of Honour*, which says "it had rained since the 8th, so that on the 9th the Danube had already risen, and delays took place in getting the infantry into the pontoons, so that it was light before they got off and the stream was then too strong to pull against."

† Not mentioned in the German account.

AUSTRIAN-GERMAN PASSAGE OF THE DANUBE AND SAVE
7–17 October 1915.



the strong stream and the presence of mines; the Danube type heavy bridge at Semendria was ready at midday on the 20th, on which day the Herbert bridge for the X Reserve Corps was begun at Veliko Gradiste below Ram, where endeavours to bridge had previously failed. Gradiste was known to be the better place, but, being on the extreme left, was thought to be too exposed to attack. Not until the 21st was the passage of all the fighting troops ended. Had not the Serbs been threatened on three sides and compelled to detach so many troops to face the Bulgarians, there is but little doubt that the German Eleventh Army would have been thrust back into the river and the Austrian Third Army would have followed; for both were for days short of guns and ammunition, which could not be got over in sufficient quantities until heavy bridges were available. As it was, the Austro-German forces, by the 17th, managed at heavy cost to push out a little farther from the rivers and to secure the enlarged bridgeheads shown on the map.

A METHOD OF LAYING AND FIRING CHARGES WHICH MAY HAVE TO REMAIN IN POSITION FOR A LONG PERIOD.

By the late T/MAJOR J. S. BECHER, R.E.

THE problem of keeping charges and firing circuits dry and in good condition, over periods of months, is one which has only occupied attention seriously during the last year.

The following principles stand for all charges laid underground or in the open, which must be ready for immediate firing and may have to remain *in situ* indefinitely.

1. Charges wherever possible should remain in factory-sealed containers.
2. When this is not possible, gelignite, or a similar explosive which, though wét, will remain serviceable for many weeks should be used.
3. Primers, detonators, and circuits should be accessible for inspection and renewal.

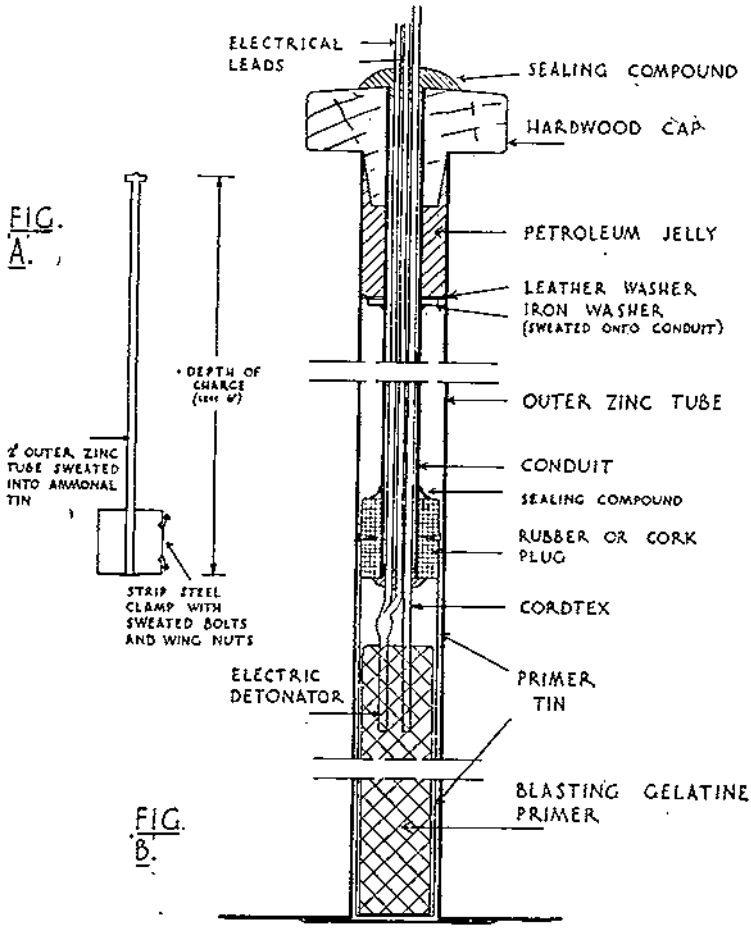
The method described below, and illustrated in the accompanying sketches, combines these principles. It also has the advantage that should it be considered safer, or should the state of emergency become less acute, detonators and primers can be easily removed without disturbing the charges in any way. They can be replaced with equal ease in a few minutes when required.

DESCRIPTION.

(*a*) *The Initiating Charge.*

1. A square 25 lb. ammonal tin is opened and emptied.
2. A long zinc or similar light tube, in diameter slightly more than a standard primer tin, is soldered into the ammonal tin as shown in Fig. A. Very good workmanship is necessary.
3. The lid to the tin is fitted with clamps tightened by means of bolts and wing nuts.
4. The tin is filled with gelignite cartridges or similar explosive.
5. The lid is clamped down and sealed with " Nobel cap sealing compound " or other bituminous substance.
6. The whole is tested under water for leaks for at least 24 hours.

7. The whole assembly is then placed in the middle of the rest of the charge in the mined chamber, the tube emerging to ground level. The rest of the charge should be ammonal in intact tins.



A METHOD OF LAYING AND FIRING CHARGES WHICH MAY HAVE TO REMAIN IN POSITION FOR A LONG PERIOD

8. The excavations are then tamped on all sides of the tube, which just sticks out at the top ready to receive the primers and detonators. Care must be taken that the tube is not bent or dented in tamping.

(*b*) *Primers and Detonators* (*Fig. B*).

The primers and detonators, contained in a cylindrical primer tin

fixed to a long rod, are lowered down the tube. The mouth of the tube is then sealed with a plug, through which the electrical leads or cordtex pass up to the outside circuits. The plug joining the primer tin and the rod should not be of wood, as the wood is liable to swell and split the tin. The rubber stopper provided with the standard 7-lb. tins for ammonal charges is suitable for this if the central hole is enlarged ; or a drilled cork stopper.

The primers should be gelignite, or preferably Polar Blasting Gelatine, and C.E. or G.C. primers should not be used.

(*c*) *Circuits.*

Electric Cable and Cordtex in outside circuits are preserved, and damage prevented by leading them through ordinary $\frac{5}{8}$" conduit. If inspection boxes are put in every ten feet, faults can be quickly located and repaired. In complicated circuits on a bridge, the various lengths of conduit can be coloured to show the circuit they are carrying, which can be referred to the same colour on the plans held for record.

BLACKANG MATI WATER-WORKS—A LOCALLY DESIGNED RAPID GRAVITY FILTRATION AND PUMPING STATION.

By MAJOR A. B. SCRASE, R.E.

A.—INTRODUCTION.

BLACKANG MATI is an island measuring about 2½ miles long by ½ mile wide, situated at the southern extremity of Singapore Island.

At the time of the work described in this article the white population numbered about 600 persons, the great majority being "Gunners" and their wives and families. There was also a small native population for which the military water supply system did not cater.

For some years previous to 1934 the water-supply of the Island had been in an unsatisfactory state. The system of supply was briefly as follows:—The rainfall was collected partly on a concrete collecting apron of about two acres at the top of Mount Serapong, and partly on a grass and secondary jungle catchment area of about fourteen acres.

The design of the former was evidently inspired by the famous system at Gibraltar, and it discharged into underground tanks of 300,000 gallons capacity, which however, were constructed of concrete, since the hill is not of solid rock.

The catchment area discharged into a small reservoir of about six million gallons capacity, formed by damming a narrow valley where it emerged on the sea shore.

In times of very heavy rainfall the tanks were filled by the run-off from the concrete apron alone; but normally this was supplemented by water from the reservoir, 180 feet below, which was pumped up a 4" rising main discharging into the collecting channel of the concrete apron.

From the collecting tanks the raw water (a mixture of visually clean rainwater and muddy reservoir water) passed *via* two slow sand filters into two service tanks of about 30,000 gallons total capacity, whence it passed to the Island distribution system.

Between the filters and the service tanks the water was chlorinated on a somewhat "hit and miss" system by a Patterson Chloronome. (Photo No. 4.) Residual chlorine tests were taken occasionally by an officer, but between these a standard dose was given, despite the fact that the factors on which this should have depended varied considerably. As a result, reports of either "too many bugs" from

the R.A.M.C., or a report in no uncertain voice of "too much chlorine" from the inhabitants, were not as rare as they should have been.

Apart from this there were other defects in the system, the chief of which were as follows :—

(*a*) There was no standby pumping plant of any description, and the existing pump was inadequate to meet the needs of the growing population.

(*b*) The reservoir water was far too thick to be dealt with effectively by filtration alone, and as the amount of pumping necessary gradually increased, and the proportion of clean rainwater correspondingly decreased, the effluent naturally became less and less satisfactory.

(*c*) The slow sand filters were of nothing like the surface area required for this type, and the filtration rate would therefore have been excessive even with clean water.

In the spring of 1934 War Office approval was obtained for modernizing the system. I was then serving in a Fortress Company and had an unexpected summons to the C.R.E.'s office, where I was told that I was excused all other duties and was to proceed forthwith to design a complete Water-Works for Blackang Mati. No more interesting job could possibly have been asked for, but at the same time, to one whose knowledge of water purification was at the time entirely theoretical, the order seemed rather a tall one !

Fortunately the Municipal Water Engineer, Mr. D. J. Murnane, who had served in a Field Company during the last war, was known to be particularly well disposed towards the Corps. My first move was therefore to pay him the first of a series of visits, at which I was able to borrow books, arrange visits to water-works both in Singapore and in Johore, and finally, having got myself sufficiently well into the picture, to start picking Mr. Murnane's brains.

B.—DESIGN OF THE NEW PLANT.

(*i*) *Location.*

Since the raw-water pumps must in any case be situated at the reservoir site, and the splitting up of a small plant is very wasteful in operating labour, there was really no choice but to concentrate everything there. If the works can be built below the reservoir level it is often possible to avoid double pumping (of the raw and clear water) but this was quite out of the question owing to the proximity of the sea.

(*ii*) *Size of Plant.*

Allowing 75 gallons per head per day, and allowing for expected future increases in the population, the round figure of 100,000 gallons daily was arrived at. There was then the choice of putting in plant of this actual capacity, and running day and night shifts, or installing three times the capacity and working an eight-hour day.

In the latitude of Singapore the latter scheme would enable a lighting plant to be dispensed with, in addition to the great saving in wages, and in a comparison of annual costs, with allowance for interest on the capital, the larger plant was found to be more economical, and was therefore decided on.

(*iii*) *Size and type of Sedimentation Tank and Filters.*

The design of any water-works hinges mainly on the choice of the type and number of filtering units employed. Slow sand filters were of course not even considered, on account both of their high capital cost and high labour cost of operating. (The reason for the former is that slow sand filters have to be nearly a hundred times the area of

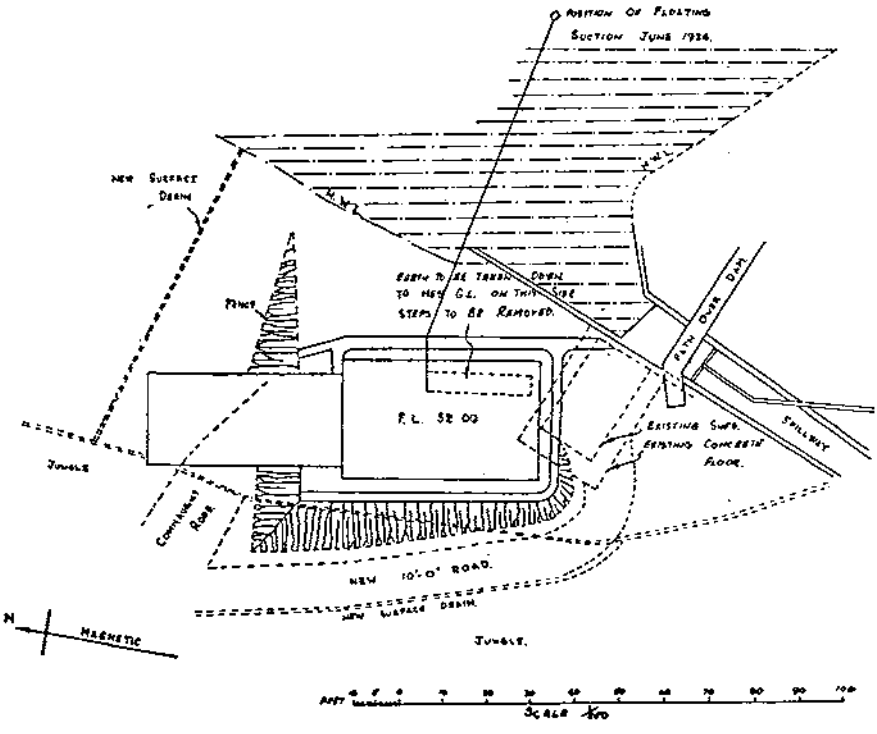


Fig. 4. SITE PLAN

rapid filters performing the same duty, and the latter follows as a natural corollary.)

The choice really lay, therefore, between Rapid Gravity and Pressure Filters. It is not proposed to discuss the relative merits of the two types, as these are fully set out in the new edition of *Military Engineering, Volume* 6, except to say that an additional advantage of the Rapid Gravity type is that it usually comes out cheaper for all but the very smallest plants. This type was chosen both for cheapness and on its merits, and the number of units was kept down to the minimum of two. Multiple units detract from simplicity of

operation and add to the cost, and it was evident in this case that in the event of breakdown of one unit the other could supply all requirements temporarily by simply working a longer day.

Sedimentation was considered essential, as previously stated, and it was decided to allow for about three hours capacity (38,000 gallons) and to make the tank 30′ by 20′ by 10′ 6″ depth of water. It was to work continuously on the under-over-under principle and contain three baffle walls 7′ 6″ apart. (See Fig. 1.) The essential point to watch, when designing a sedimentation tank of this nature, is that at no point in the tank (except of course over the collecting weir at the far end of the tank) is any part of the water accelerated to a velocity appreciably above that of the general movement in the tank. This implies that the entry and exit of the water must be spread over the whole width of the tank, the openings in the "under" baffles must be of sufficient area, and the "over" baffles must be sunk to a sufficient depth to give the area required. In this case the average velocity through and over the baffles was designed to be between 1 and 2 feet per minute, and the fact that an inch or two of fine silt, lying in a perfect streamline contour, was always to be seen on the top of the "over" baffle, proves that very little disturbance was caused.

Another small point to watch is that a small hole is left in the bottom of the "over" baffles, so that the pressure is equalized on both sides of the wall when the tank is being filled or drained.

The sedimentation tank was designed with a hopper bottom, as shown in the sectional elevation, with the intention that it should never need draining in order to clean out the mud, and this feature appeared to work very well in practice.

The filters were made 9′ 6″ square, as this fitted in very well with the 20′ width of the sedimentation tank. This gave the rather low rate of 70 gallons per square foot per hour, which meant that in the event of one filter being out of action the output of the remaining one could be increased 50% without overloading.

(*iv*). *Method of Washing Filters.*

The three modern methods of washing rapid filters, designated according to the means employed to assist in breaking up the filter bed, are as follows :—

(*a*) Water plus air.
(*b*) Water plus mechanical agitation.
(*c*) High velocity water wash.

The latter system, which was the one adopted, is a comparative newcomer to this country, but has been employed with great success in the U.S.A. for many years. The advantages in simplicity and reduction of plant are obvious, and about the only disadvantage is that a higher percentage of wash-water is required than with the other two systems.

The wash-water is admitted through evenly spaced "roses," or

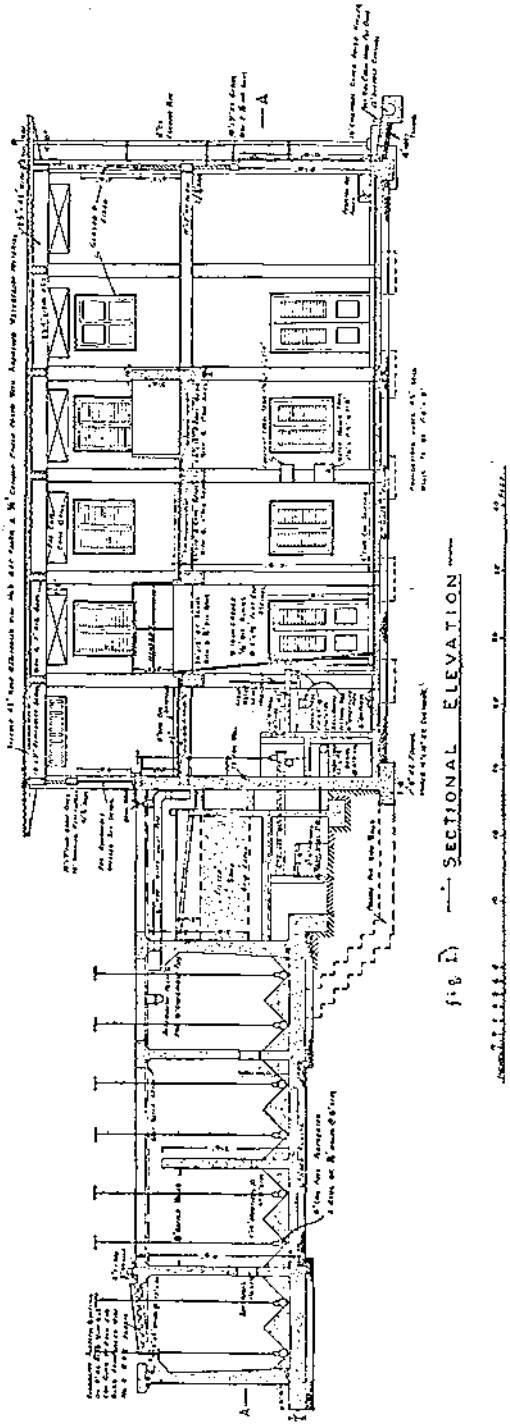
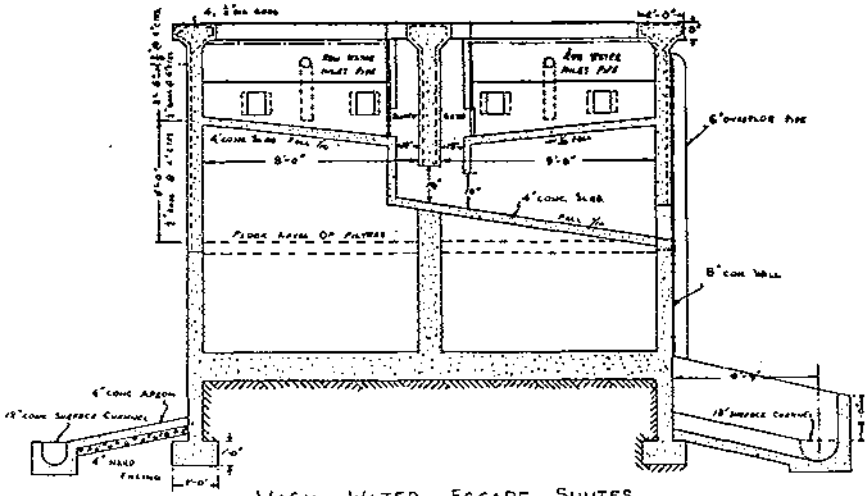


Fig 2.

other distributors in the base of the filters, at such a rate that the whole sand bed is lifted and held in suspension. Meanwhile the dirt, being lighter than the sand, is carried over into the wash-water troughs. From these the wash-water flows either to waste or into a wash-water retention tank where the dirt is allowed to settle; the water being eventually returned either to the reservoir or to the sedimentation tank.

The details of the wash-water collecting troughs are of great importance. It is essential that every inch of the trough draws off the same quantity of water, and to achieve this its lips must of course be *dead level*, and if the troughs are of concrete it may even be worth while to fit them with brass knife edges. For the same reason the floors of the troughs should be given a slope of about 1-10; if



WASH WATER ESCAPE SHUTES.
SECTION D-D

fig. 5.

Scale

they are made level the troughs will probably flood and the down-stream ends will carry off less water. (See Figs. 1 & 5.)

The rate of admission of wash-water should be such that it rises vertically in the filter at about 24 inches per minute. In this case, with small filters, it worked out at 1,100 gallons per minute, and it can readily be seen that with big filters enormous flows are required for washing on the high velocity system. The time of washing is of the order of five minutes, but naturally depends on how dirty the filter has been allowed to become.

The usual method of obtaining the large flow required is either to install special wash-water pumps, or to build wash-water tanks of sufficient size close to the filters. In this case, however, it was found that by replacing the 4" rising main with a 6", which was necessary in any case, it would be possible to obtain sufficient water without

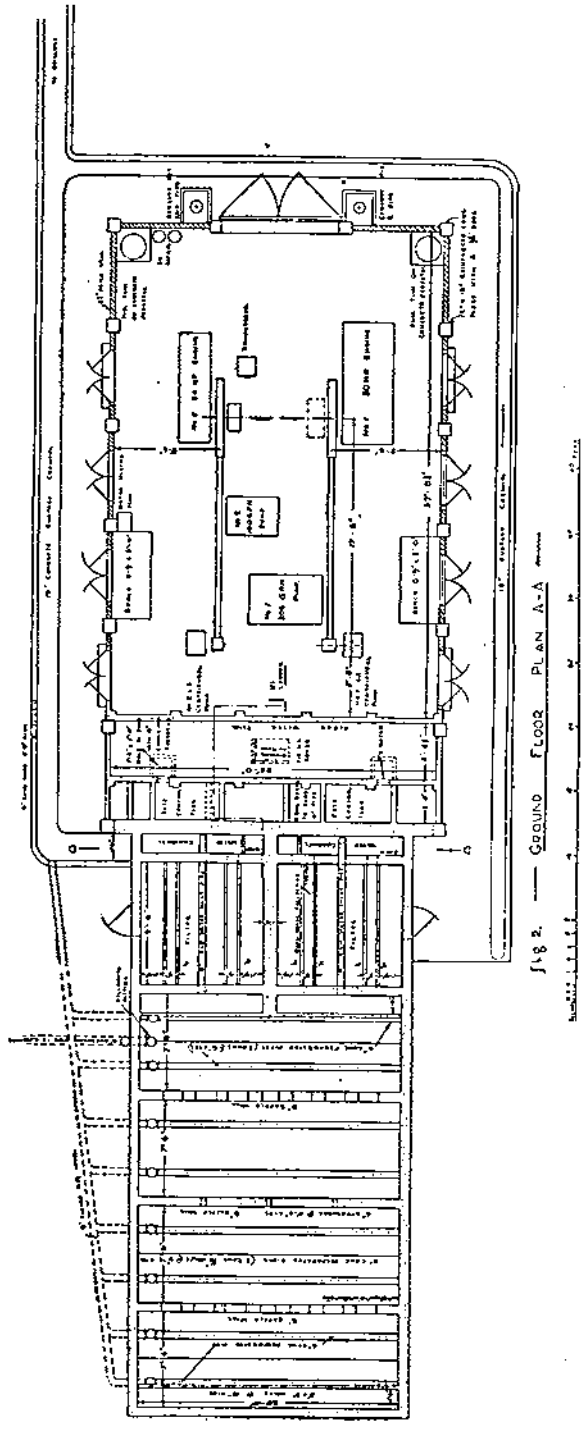


Fig 2. — Ground Floor Plan A-A

special provisions, provided that the clear-water pump was always running while washing was in progress. The new rising main had of course to be connected to the *bottoms* of the storage tanks on the hilltop.

No wash-water retention tank was installed, as raw water was not usually very precious, but arrangements were made so that the first-run and dirtiest wash-water was run to waste, and the cleaner water from the latter end of the wash could be returned to the reservoir.

(*v*) *Chemical Treatment Necessary.*

An examination of the reservoir water was kindly undertaken for me by the Municipal Water Engineer, and it was found that a satisfactory "floc" could be obtained with the addition of alum alone.

The Ph value (hydrogen-ion concentration) of the water, after the addition of alum was rather on the acid side, and it was therefore decided to allow for the addition of lime to the filtered water, both in order to improve its drinking properties and to diminish the tendency to encrust iron pipes.

Apart from chlorination the only other treatment of the water which could be classed as chemical was aeration; aeration of the raw water was tried and abandoned, as will be described later, and the filtered water was given some degree of aeration by allowing it to fall several feet vertically into the clear water tank.

(*vi*) *The Water Circuit.*

In order to make the descriptions of the plant clearer it is proposed to trace the course of the water from the reservoir to the storage tanks:—

The raw water was drawn from a home-made floating suction inlet, consisting of a length of flexible suction hose supported by a 65 gallon diesel-oil drum, by one of two centrifugal raw-water pumps. The necessary quantity of alum was injected on the suction side of these pumps, which ensured the turbulence so necessary for the initial formation of a floc. From the raw-water pump the water passed to six aerators at the far end of the sedimentation tank, whence it flowed down a short delivery chute to a distribution trough having numerous under-water outlets. The path of the water was then under-over-under to the far end of the tank, where it passed into a collecting trough, from which it flowed *via* two valved 6″ pipes to the two filters. (These pipes actually terminated, not over the filter beds, but in the main wash-water discharge duct, I have not seen this done elsewhere, but the object was to prevent a careless operator from damaging the sand bed by opening up the valve with a rush. This it effectively did, as the water flowed gently over the edges of the wash-water troughs.)

The filtered water, after passing through the strainers at the bottoms of the filters, passed to the two rate-controllers, on the accurate functioning of which the success of a rapid gravity filter plant largely depends. From these it issued directly into the rate-control tanks (where the lime from the lime-feeder on the floor above

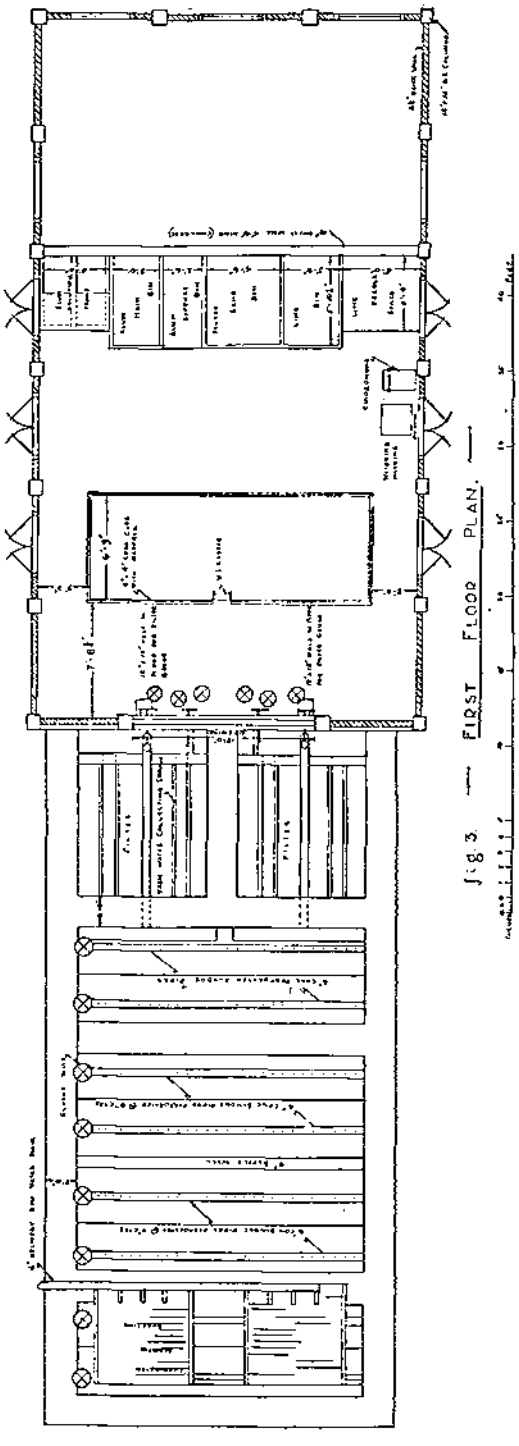


Fig. 3. — FIRST FLOOR PLAN.

joined it in the form of lime water) and thence over measuring weirs into the clear water tank below.

From the clear-water tank the water was drawn by the clear-water pump, on the suction side of which it was chlorinated on the wet feed system by the Chloronome on the first floor, and pumped through the main meter to the high level storage tanks.

(*vii*) *Use and Conversion of Existing Plant.*

It was as usual essential, on the score of cost, to use as much as possible of the existing plant. In fact, everything but the two slow sand filters and the rough shed covering the old pumping set, was made full use of.

The old pumping set, consisting of a 20 B.H.P. Heavy Oil Engine driving a 100 G.P.M. reciprocating pump, was used to form the stand-by clear-water pumping set. It was not intended for normal use as it was only able to deal with the output from one filter. The same engine also drove from its flywheel the stand-by raw-water pump, which had to be purchased new.

The prime-mover for the new main raw- and clear-water pumps was provided by a 30 B.H.P. semi-diesel oil engine salved from a Magazine Cooling Plant which had recently been dismantled. (Photo No. 3, on left.)

The 4" rising main, although not used in this scheme, was used to replace an overloaded 3" main in the Island distribution system.

The old Chloronome from the top of the hill was of course re-erected on the first floor of the station, and with one or two replacements was as good as new.

The old concrete collecting apron presented rather a problem, since it could not be allowed to discharge into the high level storage tanks, as these now contained pure water. On the other hand it formed, with its 100% run-off, a much greater proportion of the effective catchment area than its size would indicate, and the whole of the discharge had to be conserved. This was done by sealing the tank inlets, and re-grading the collecting channels to deliver into a sump, from which the water was taken in a short length of 12" pipe to an open concrete channel leading direct to the reservoir.

The outlets from the old filters to the clear-water service tanks were merely fitted with ball valves, and connected directly to the collecting tanks, thus maintaining the former always full, which gave a slight but much appreciated boost to the distribution system.

(*viii*) *Method of putting out the Contract.*

The method employed is not recommended for future use ! It was apparently essential in order to comply with Regulations that the Chinese Term Contractor should have the opportunity of tendering. On the other hand it was obviously absurd to expect him to tender for specialized water purification plant or pumping sets. A compromise was therefore effected in which the job was split up into the following three contracts :—

Photo. No. 1.—View from Reservoir showing Pump House nearly completed and shuttering for Sedimentation Tank.

Photo. No. 2.—Control Balcony showing valves, filter gauges, and water testing equipment.

Photo. No. 3.—View of pump room floor.

Blackang Mati water works 1, 2, 3

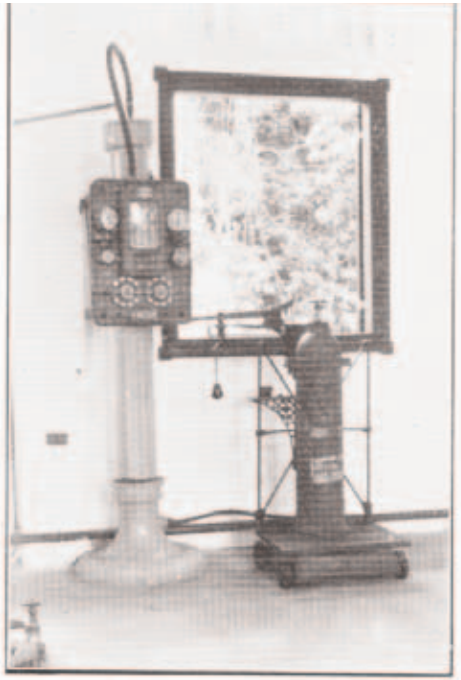


Photo. No. 4.—Paterson Chloronome installed on balcony.

Photo. No. 5.—Lime Feeding Machine driven by ¼ H.P. Pelton Wheel.

Blackang Mati water works 4, 5

(*a*) Pumping station, Sedimentation tank, Filter tanks, Filter piping, Pumping main, etc.
(*b*) New Pumps.
(*c*) Specialized water purification plant.

(*ix*) *Pumping station, Sedimentation tank, etc.*

The T.C.'s tender was accepted for the first contract, and although everything was put right in the end he was naturally quite out of his depth with the complicated system of valves and piping which controlled the action of the filters. There were also the usual complaints of the specialist contractor that the T.C. had not made all openings, foundations, etc., exactly according to his drawings.

It is not proposed to say very much about design involved in this contract, as this can be seen from the drawings. The pumping station had to be on two floors to give the necessary head for the chemical feeds, but as comparatively little upper floor space was required, this was made more in the nature of a very wide balcony. This made the pump floor much cooler and also enabled the attendant to keep his eye on his assistant (a coolie) when he was engaged above.

I think it might be worth mentioning, for the benefit of other officers who may at any time be driven back to first principles in reinforced concrete design, that great assistance was obtained from that excellent S.M.E. publication *Notes on Cement and Concrete, Part II. Reinforced Concrete.*

It appeared that for practically all R.C. work in Singapore District B.R.C. Fabric was specified, and as a result the draughtsmen merely used the appropriate tables in the firm's handbook when designing pillars, beams, slabs, etc. I very soon found out that the said handbook provided no assistance whatever in the design of large water tanks, and it was then that I sent to Chatham for the S.M.E. booklet.

Another trouble about the B.R.C. handbook is that their fabric, being of special steel, is stressed in design to a high figure, which, if I remember rightly, amounts to 25,000 lb. per sq. inch. This is excellent for economy of steel, but unfortunately it does not make for water-tight construction, in which the best practice is to stress the steel even below the old standard 16,000 lb. per sq. inch. In this design the steel in the sedimentation and filter tanks was only stressed to 8,000 lb. per sq. inch. No tables, or even formulæ, were available for working at this stress, and the graphs at the end of the S.M.E. booklet saved literally hours of calculation.

(*x*) *Pump Contract.*

This consisted of an order for two centrifugal raw-water pumps and one reciprocating clear-water pump. The choice of type of the latter may cause surprise, although according to the rule given in the new edition of *M.E. Vol. VI* the case was a border-line one—the total head in feet and the output in gallons per minute being both about two

hundred. The choice was actually made on expert advice, owing to the alleged possibility of overloading troubles with a centrifugal pump when the head was suddenly reduced to 15 or 20 feet on the opening of the wash valve.

My own subsequent opinion was that no normally designed pump could possibly overload (in a B.H.P. sense) in these conditions. On the other hand a 200% or 300% increase in output, which a centrifugal might have given when the wash valve was open, would have been a definite advantage ; for this reason I think that if I were repeating the scheme I should prefer this type of pump.

(*xi*) *Purification Plant Contract.*

A large part of the gear that would normally form part of this contract was of local design, and it was therefore limited to the supply and erection of a comparatively small number of components. The chief of these were as follows :—

(*a*) *The under-filter drainage and wash-water distributing system :*— In the tender accepted this consisted of two 5" main distributing pipes, radiating from the centre of the filter, from each of which there projected at right angles ten 2" distributing pipes. Into each of these were screwed about six "roses" similar to those found on a garden watering can, though considerably larger. After erection the whole lot was grouted in, leaving only the curved detachable covers of the roses projecting.

(*b*) *Rate controllers :*—The exact type was not specified, other than that they should be suitable for installation in the works as drawn, without excessive alteration or cutting away of concrete, and that they should work in conjunction with notch weirs.

The type sent was too simple, and as it failed on test to comply with the specification of maintaining a constant flow, irrespective of the state of the filters, the makers were called upon to produce a device that did so effectively. In the meanwhile the filter output had to be kept constant by frequent adjustment of the outlet valves ; this was a nuisance for the attendant, but with only two units to look after it was not difficult.

The original type consisted of nothing more than an equilibrium valve controlled by a cylindrical guided float, and a 90-degree "V" notch, the whole lot being fitted in the rate-control tanks. Now it is well known that any form of governor depends on some change in conditions to cause it to operate, and absolute constancy is therefore impossible, but in this case the principle was carried to excess ! To start with, "V" notches were not particularly conducive to accuracy, since at the working flow, well up the notch, quite a small change in level produced a considerable change in the rate of flow. Add to this the fact that the floats were provided with a considerable mechanical advantage over the valves, and it becomes fairly obvious that good governing could not reasonably be expected.

The type sent in replacement was quite ingenious, and incidentally

utilised nearly all the original components. The main floats were now placed in water-tight tanks inside the rate-control tanks, and the governing was done by a small float in the latter tanks. This controlled a small three-way valve, according to the position of which the float tanks were either put in connection with the main tanks, isolated altogether, or connected to the drain. I was unfortunately moved to another district before this was installed, and am in consequence unable to say how well it worked, but as the travel of

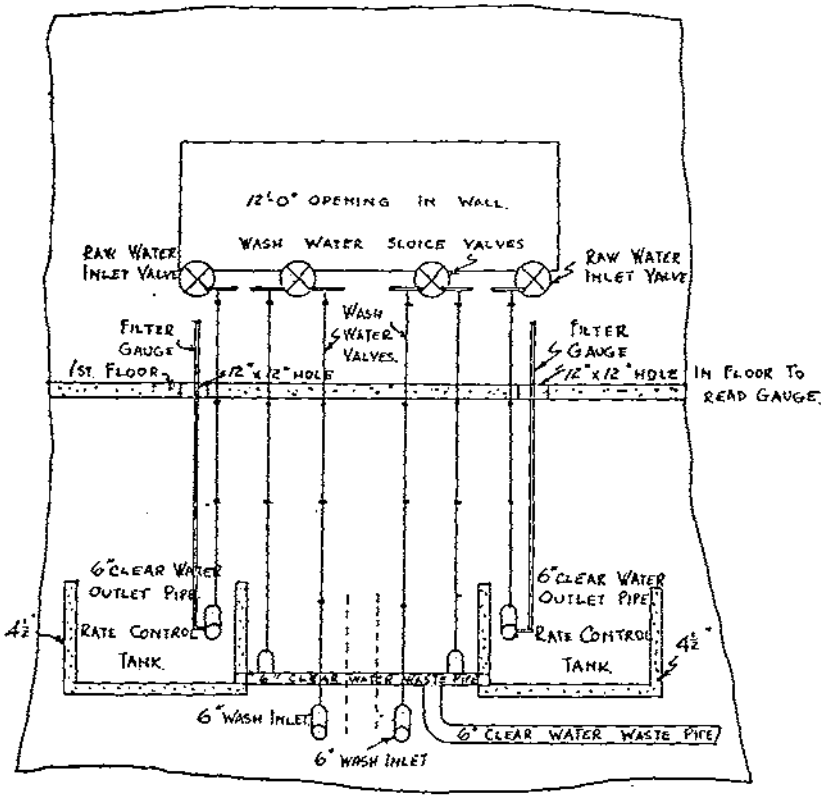
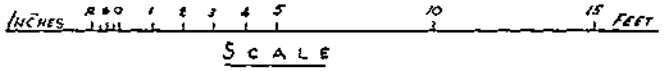


Fig. 6. SECTION THRO' RATE-CONTROLLER TANKS.



the auxiliary valve was a mere fraction of an inch there appeared to be every chance of obtaining good governing.

(*c*) *Loss of head gauges* :—The object of these, as the name implies, is to register the loss of head in the filter, so that the operator can readily see when the filters require washing. If manufacturers are allowed free rein these gauges can run away with quite a lot of money, as several firms have their own patent systems, some acting on columns of mercury at a distance from the filters, some recording

electrically, etc. Where the layout permits, however, the best kind of gauge, as well as the cheapest, is simply a long gauge glass fitted to the filter outlet pipe on the filter side of the rate-controller. This is taken slightly above the filter water level, and is graduated downwards in feet with the zero mark at rest water level. When the filter is clean, and the rate-controller is in consequence almost closed, the working level in the gauge will perhaps be a foot lower, but as the filter gets dirty the level will gradually drop until it is about eight feet below. The time to wash is shortly before the rate-controller reaches its fully open position, and this will correspond to a definite reading of the gauge. The gauge also tells one how efficiently, or otherwise, the filter has been washed, and it should never be omitted.

(*d*) *Rate of flow meters* :—Again complicated apparatus was ruled out, and what was called for was a dial mounted on the first floor and controlled by a float in the rate-control tanks. The dial was to be calibrated with the weir notches supplied in connection with the rate-controllers.

(*e*) *Clear-water tank Level Indicator* :—To consist of a float controlling a simple pointer rising and falling on a depth scale painted on the front of the tank.

(*f*) *Lime-feeding machine.*—A dry feed machine was specified, and, since no electric power was available, and counter-shafts were definitely not desired, it was to be driven by water power. The one supplied was driven by a very neat little $\frac{1}{2}$ B.H.P. Pelton wheel. (Photo No. 6.) As supplied the machine gave rather a coarse feed, which could not be adjusted with sufficient accuracy, but on representations being made the manufacturers supplied a reduction gear free of cost.

(*g*) *Alum-feeding arrangements* :—The concrete alum solution tank and the method of feeding were designed by me, so that all that the contractors were required to supply were a few alum-resisting fittings, and a calibrated needle valve or other device for passing definite quantities of alum solution.

The "device" supplied consisted of a small alum-resisting casting with a calibrated orifice at the bottom, a needle valve controlled inlet at the side, and an open gauge glass fitted into the top. It can be seen that the flow through the orifice is dependent on the level in the gauge glass, which rises and falls with the opening and closing of the needle valve, and that the glass can therefore be graduated in gallons per hour. (See Fig. 7.)

This device has been described in detail because it is so simple that it could probably be quite easily made up in the field from old boiler fittings, etc. The orifice wears in time, but it is a very simple matter to re-calibrate it and fix a new scale behind the gauge glass.

When admitting a solution to a suction pipe under negative head, a water seal must of course be maintained. In this case the alum solution was allowed to fall from the above-mentioned sight

feed device into another small tank immediately below. This tank had a restricted outlet, and was kept always full by a ball-valve connected to the raw-water main, and thus maintained the water seal. It should perhaps have been made clear that the sight feed device does not do away with the need for a constant head supply of the solution, which must be fed as usual from a ball-valve controlled tank or a float outlet; what it does do is to enable the dose to be accurately varied.

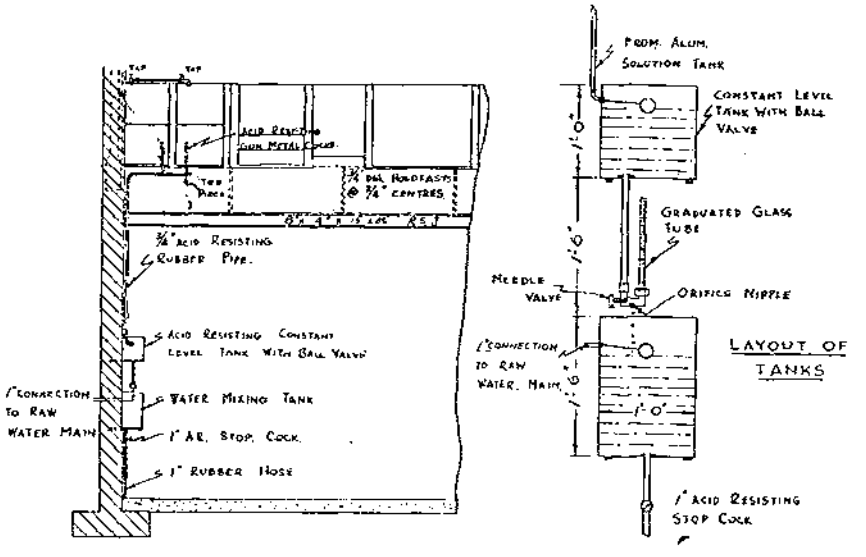
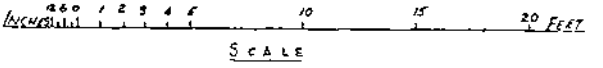


Fig. 7. SECTION SHOWING ALUM ADMISSION ARRANGEMTS.



C.—OPERATION OF THE PLANT.

It may be of interest to know that the plant is run successfully by a skilled Chinese fitter, assisted by one coolie.

He was taught by me to test the water at various points for Residual Chlorine, Ph value, and Alkalinity in parts per 100,000. The first two tests are carried out very simply by means of a Wallace and Tiernan Comparator, and are made at least twice per day, whereas the latter, which involves a chemical experiment, is carried out once a day only. The Ph value and alkalinity tests on the raw water give warning of any change being necessary in the alum dosage, and on the filtered water they decide the amount of lime to be added. Ah Kuan made rather heavy weather of the alkalinity test to start with, but he really mastered it surprisingly quickly on the whole. I was a little nervous at first of the fact that it involved issuing him with a bottle of pure chloroform, particularly as he was always telling me about his enemies in the Town who were threaten-

ing to shoot him for some obscure reason. To the best of my knowledge, however, the chloroform was not used to settle with them!

D.—EARLY TROUBLES.

The trouble with the rate-controllers and the lime-feeding machine have already been mentioned, though these were fortunately the contractor's troubles rather than mine. Since it is indubitably when things do not go quite as planned that one learns the most, it is proposed now to describe a couple more rather interesting "snags," the first of which concerns the aeration of the raw water.

The type of aerator I had in mind when tendering was rather on the lines of a laboratory aspirator, in which the water would draw in its air in passing through a specially designed jet. The contractor was, however, allowed to supply any type which would pass the full output of 12,500 gallons per hour without introducing more than six feet additional head. What they actually supplied was a set of six roses, not unlike the filter strainers, but of course with much larger holes. These were fitted pointing nearly vertically upwards, so that the fountain of water fell on to the concrete delivery chutes at the head of the sedimentation tank.

When the great day of completion came at last, I duly ran a series of tests on the raw water to determine the correct alum dose, and obtained a perfect "floc" in one of six gas-jars. This exact dose was given to the system, the raw-water pump was started up, an impressive and ornamental fountain display was given by the aerators, but alas, no sign of "floc" appeared in the sedimentation tank, and the "filtered" water arrived in the rate-control tanks with its distinctive shade of ruddy brown almost unaltered!

After trying several different alum doses, with no success whatever, I must admit that I became somewhat downhearted, and carried my tale of woe to my friend the Municipal Water Engineer. He was also puzzled, but said that the only possible cause would be the aerators, and suggested trying the effect of removing them. This was done, and immediately a beautiful "floc" formed, and after a few hours' running the water at the far end of the tank was comparatively clear. The filter effluent was not very good at first, but this is normal with a new sand bed, and after about a week's running it came through clear and sparkling.

The explanation was apparently that the "floc" was of a very quick-forming variety, and that it formed during the passage of the water through the raw-water main, thus being badly broken up by the spraying at the aerators. When the alum is first added, the more turbulence the better, but when once the "floc" has formed it must be treated very gently.

The second snag concerns an unfortunate but interesting accident which befell one of the two filters a few weeks after starting up. The attendant was washing the filter in the usual manner when suddenly a stream of water shot from the top of the filter gauge and

struck the roof of the building, and a second later, before he had time to close the wash valve, a minor earthquake appeared to occur in the filter. On draining the filter and digging out the sand a sorry sight presented itself, the filter floor looking as though a small charge of H.E. had been detonated beneath it!

The under-drain system has already been described, but it was not mentioned that the pipes were made of asbestos-cement and fitted loosely together without joints. My explanation of the accident, which I am fairly confident is the correct one, is as follows:— Under normal washing conditions practically the whole of the 180 feet static head from the storage tanks is lost in friction, the residual head being about 15 feet. The 6" rising main was a bitumen lined steel pipe, and it appears that the lining must have had "feathers" of bitumen projecting at various points in the pipe, and that the high rate of flow during washing (900 g.p.m. through a 6" pipe) gradually tore these away. There was definite evidence of the loose bitumen, and my theory is that the pieces must have found a temporary lodging somewhere, and then have all come down with a rush, thus suddenly blocking a number of the strainers. The result would be an enormous increase in pressure, due partly to the static head, but mainly to the momentum of the column of water, and this pressure must have sufficed either to burst the pipes, or issuing through the joints, and finding a void due to bad concreting, to have burst the concrete direct. The makers stoutly denied the possibility that the pipes could have burst, but several were in pieces after the accident, and personally I have my doubts!

To guard against a repetition with the other filter, a dirt box from a very large water meter was bought secondhand from the Municipality, and fitted in the rising main. I think it cut down the wash-water by about 5%, but there was luckily still enough for an effective wash.

E.—Conclusion.

I will conclude this article by reassuring anyone who may be wondering whether he is likely to have to carry out the detail design of any similar plant under peace conditions.

After the design was finished it was learned, that, had the whole contract been given to one of the water purification firms, such as Pattersons, Candy Filter Company, Bell Bros., etc., they would have been prepared to do the whole of the detail design of the purification system. I have been told that water purification is a sort of mixture between an exact science, and an art which comes only with practice; so that for permanent schemes it is probably wiser, unless really expert advice is available, to leave the detail design to well-known firms.

In this case the advice was available, and the result was an original and effective plant, the saving of several hundred pounds, and some exceptionally thorough training for the author.

CONCUSSION CHARGES.

By T/MAJOR A. G. PEART, R.E.

" Charges worked out by the formulæ given in *M.E. Vol. IV, Sec.* 38, are generally sound, but in the case of certain structures the charge is excessive. Experience in the demolition of houses in Palestine by this method shows that considerable reduction of charges may be made if the principle of the unbalanced blow is followed."—(Extract from *F.E.P. No. 7, Ch. VIII, Sec.* 44, *para.* 1.)

THE following description of a demolition carried out recently by my unit is thought to be of general interest, in that, from analysis of its results, a much clearer guide to the reduction mentioned in the quotation above is obtained.

On 13th March, 1941, my unit was approached by the commander of a nearby R.A.F. station, with a view to the demolition as soon as possible, of a " flying obstruction."

On the next day, 14th March, the writer and a N.C.O. went over to the R.A.F. station to reconnoitre. It was decided to blow at 1300 hrs. on the next day, 15th March. This reconnaissance took $2\frac{1}{2}$ hours in daylight and produced the following results.

RECONNAISSANCE.

The " flying obstruction " consisted of a public house—The " Windsor Castle "—and a number of outbuildings (shown on the attached plan). The details of these buildings were :—

(i) The " Windsor Castle." Two storey masonry. 24" thick with one storey $13\frac{1}{2}$" brick additions marked Nos. 7, 8, 11 and 12 on the attached plan. 7 rooms on ground floor. Ceilings already removed. Gable ended, tiled, roof at height above ground about 35 ft. Cellar under rear portion. Oak floor joists of 1st floor in position plus some floor boards. Partition walls $4\frac{1}{2}$" brick.

(ii) Outbuilding No. 1 (see plan). 18" masonry single storey with 9" brick pigeon loft centrally placed. Height of loft about 35 ft. Brick arched vault under, 8' × 6' × 4' high. Concrete floor at height above ground 12'. Entrance to vault by hole in brick wall about 2' 6" diam.
Remainder, four sheds about 20' high with tiled roofs.

(iii) Outbuilding No. 2 (see plan). 18″ masonry shed 360 square feet floor area. Tiled roof 20′ high. Gable ended. Large double doors centrally placed giving " through " passage. Floor joists of loft remained as well as loft floor boards.

(iv) Outbuilding No. 3 (see plan). Two sheds. 13½″ brick with sloping roof. Highest point about 10′. Total floor area 200 square feet. No doors.
Adjoining, three small hen houses. 4½″ brick with sloping roof. Highest point 5′. Open fronts.

(v) Outbuilding No. 4 (see plan). 9″ masonry outside lavatory with 9″ brick wall 20′ long × 4′ high adjoining.

(vi) Outbuilding No. 5 (see plan). 4½″ brick outside lavatory backing on to small shed with open front.

The following information was also noted :—

(*a*) Timber. Sufficient floorboards remained for all blocking of windows, doors, etc.

(*b*) Situation. Adjoining a main highway.

(*c*) Traffic. The R.A.F. agreed to close the main road for 500 yards on either side of the buildings on receipt of warning that all was ready.

(*d*) Clearing of rubble. The Aerodrome Clerk of Works agreed to put on a bull-dozer to clear the main road for traffic after the demolition.

(*e*) Removal of Aircraft. The R.A.F. agreed to remove all aircraft to the other side of the landing ground. This was about four times greater than the normal safe distance but it was felt that unit funds would be hard put to it if a court of inquiry found them guilty of losing by neglect a few heavy bombers !

(*f*) Local warning. The local police were informed and agreed to warn all householders within a radius of one mile, to open their windows from 1230 hrs. onward.

(*g*) Information from the Aerodrome Clerk of Works showed that the buildings were disconnected from water, gas, electric light, etc.

(*h*) There was no main drainage or sewer system at this point on the main road, but there was a buried G.P.O. telephone cable which ran along the front of the " Windsor Castle " at a distance of 9 feet from the front wall.

Calculations.

A rough dimensioned plan was made on the site and the position of charges and firing circuit shown. A rough check of the two outbuildings marked Nos. 1 and 2 on the plan showed that the formula $C = \frac{KAT^2}{10}$ was out of the question as a basis for calculating charges

owing to a limitation in the supply of available explosive. A rule of thumb method was therefore devised, using the principle of unbalanced small charges (*F.E.P. No. 7, Ch. VIII, Sec. 44, para. 3*) with additional charges for chimneys, etc.

The rule of thumb was as follows :—

50 lb. per large room—300-500 square feet.
25 lb. per small room—150-300 square feet.
10 lb. per very small room under 150 square feet.

As these charges were so much below those calculated by formula in the case of the larger rooms, it was decided to employ in addition two extra large charges in the two suitable places which were available, *i.e.*, the cellar under the "Windsor Castle" and the arched vault under outbuilding No. 1.

It was thought that the effect of these charges would be to shake the whole area and so ensure that the small unbalanced charges would have an easier job to do.

The charges as calculated by the rule of thumb above were increased slightly where there were substantial corners and subdivided for the purpose of laying where it was considered necessary to produce a couple on the walls. In the case of outbuilding No. 2 the charge was doubled and placed in all four corners as the large shed doors were opposite each other.

FIRING.

The whole was connected up with Cordtex and Cordtex junction boxes to a ring main circuit as shown in *F.E.P. No. 7, Ch. III, Sec. 24, para. 7, Fig. 18* with a No. 33 electric detonator and a No. 27 and six feet of safety fuze. The No. 33 was connected by 400 yards double cable to a Mk. VII Exploder. It has been pointed out to the writer, and he agrees, that the ring as used, and shown in the attached plan, is inadequate as a ring main in this case, owing to the number of branches and sub-branches. It is considered that a safer method would have been to take a lead from the junction for assembly No. 12 to the junction for assembly No. 11, and also possibly to No. 4.

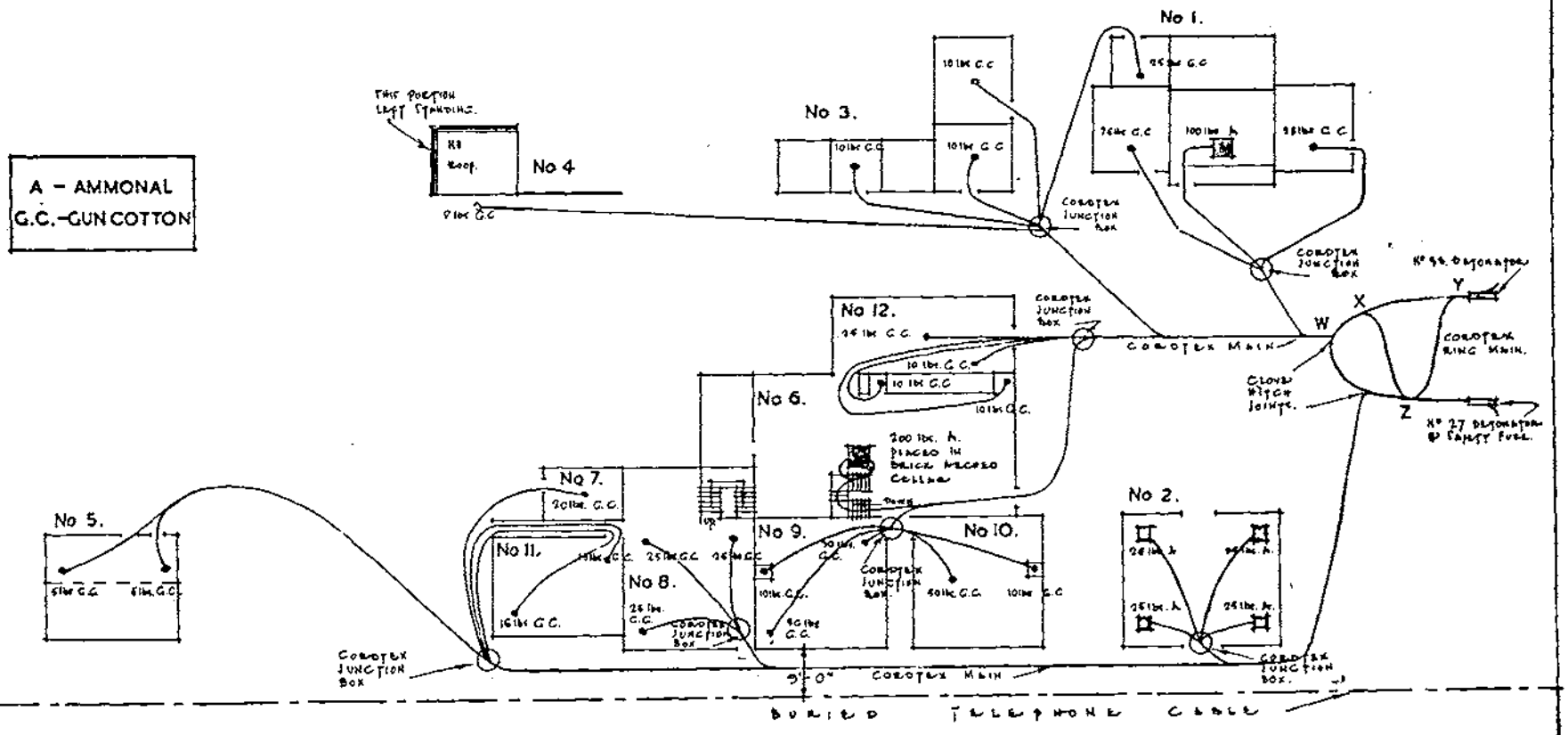
LAYING OF CHARGES.

All charges were laid untamped on the floor with the exception of the 10-lb. chimney charges, which were laid about 5 feet above floor level in holes made by removing bricks from the side of the flue.

The work of laying and connecting up of charges and the boarding up of windows and doors were carried out concurrently. The time taken was 3½ hours by a party of 22 working numbers. These men were fully trained recruits who were undergoing further training as potential N.C.O's.

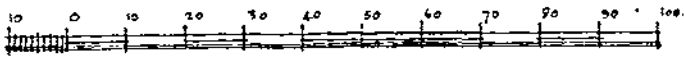
APPENDIX 'A'

Positions of Charges & Details of Firing System.



MAIN ROAD

SCALE – 20 FEET TO 1 INCH.



Results.

One foot of safety fuze was tested and took 30 seconds to burn. When all was ready and the electric circuit had been tested, the 6-foot length of safety fuze was lit and the firing party walked back to the exploder with the intention of pressing the handle at the same moment as the safety fuze should have gone off. The safety fuze however went off 15 seconds too soon.

There was very little noise and a lot of brown smoke which took some time to clear away. This was a period of real suspense for the writer, as the news that " the local " was being blown up had drawn a large and sorrowful number of spectators and the writer had vivid memories of an occasion in the past when he had produced a colossal bang and clouds of smoke and found to his horror when it cleared that everything was still untouched !

After some time, however, it became apparent that in this case all had gone according to plan and on inspection it was found that the demolition had been completely successful with the small exception that two walls of outbuilding No. 4 still stood although the roof was gone.

The No. 33 detonator was found attached to a length of Cordtex marked XY on the attached plan. It is probable that the explanation of this is that the detonating wave from the No. 27 split at Z and the wave *via* ZX met the wave *via* ZW somewhere about W and cancelled out.

Very little material flew. The bits which did were mostly timber from the roofs and roof tiles. The furthest piece was about 50 yards from the buildings.

Conclusions.

(*a*) Size of charges.

From inspection of the results and the way in which the debris fell, it was considered that the charges could not have been safely reduced, with the possible exception of the 200-lb. charge in the cellar. This left a 30-foot crater, and, allowing for its original depth below ground in the cellar, the crater seemed a bit large.

(*b*) Boarding up of openings.

It seems reasonable to assume that, in the case of houses, there will always be sufficient timber at the site.

(*c*) Time.

The boarding up of openings and the laying and connecting up and testing of charges can proceed concurrently and the total time is more likely (except in the case of a single charge) to be governed by the time taken to lay, connect up and test, than by that taken by boarding up, etc.

(*d*) Calculations.

This demolition is further proof that the formula $C=\frac{KAT^2}{10}$ is very extravagant in explosive, at any rate for buildings of this nature. A linear expression would seem more reasonable, if the resulting couple from unequal charges is considered as the destructive agent, and the symbol "A" in the formula might be replaced by another, say "S", where S=the perimeter in feet of the room in question.

NOTE.

Concussion charges, as calculated from the formula, $C=\frac{KAT^2}{10}$, are without doubt considerably in excess of those found to be successful in practice, except in the case of small floor areas of the order of 100 sq. ft. A suitable formula to give economical charges throughout the range would be too complicated for practical use in the field.

An analysis of theoretical and practical charges is given below. From this it appears that a formula, $C=\frac{KST^2}{5}$, where S is the total perimeter of the room in feet, gives charges approximating more closely to those found adequate in practice than the original formula $C=\frac{KAT^2.}{10}$ The excess, in the case of medium and large rooms, can be accepted to cover the hasty fixing, which such charges will often demand when employed for clearing fields of fire.

Analysis of Concussion Charges.

Nature of Room	Floor Area in Sq. ft.	Dimensions	Wall Thickness	Charge given by $\frac{KAT^2}{10}$	Rule of Thumb	Charge given by $\frac{KST^2}{5}$	Remarks
Large	300–500	Say 20×15	2 ft.	250 lb. for 300 sq. ft.	50 lb.	110 lb.	S=2(20+15) ft.
Medium	150–300	Say 15×10	1½ ft.	50 lb. for 150 sq. ft.	25 lb.	35 lb.	S=2(15+10) ft.
Small	Under 150	Say 10×10	1 ft.	12 lb. for 100 sq. ft.	10 lb.	10 lb.	S=2(10+10) ft.

Until such time as more information is available about such charges, no alterations will be made to existing formulæ in the demolition manuals.

WHAT HAPPENED AT SEDAN.

By CAPTAIN PAUL W. THOMPSON.

(Reprinted from *Infantry Journal* (Washington), April, 1941.)

THE breakthrough along the Meuse in May of 1940, leading as it did to " the greatest campaign of annihilation in history," is already claiming page after page in the military press of the world. Of course, no complete account of the campaign has yet been forthcoming ; but article by article, additional facts are becoming known. Recently, in the European press, two articles of special importance have appeared. One, written by the German Lieutenant-Colonel Soldan,* presents a fair generalized view of the German plan and operations. The other, written by the Swiss Colonel Daniker,† reveals hitherto unknown facts concerning the French plan and operations. These two articles, supplemented by a few others, form the basis for this present account.

I

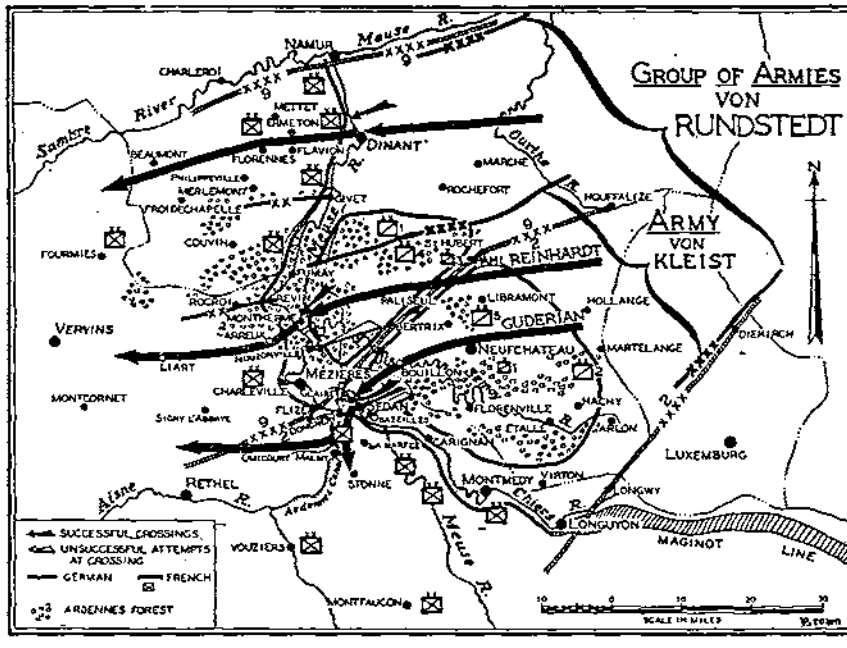
The elements of the general situation at the opening of the campaign in the west are as follows : Between the northern extremity of the Maginot Line and the sea stood large French and Allied forces, ready to meet anything in the way of a new Schlieffen envelopment (or, the Germans say, ready to push into Holland, and thence south into the Ruhr area). The Germans, who " enjoyed no numerical superiority over their combined enemies," (that is, if one counts as " enemies " before May 10th the Belgian and Dutch forces) attacked over the three borders at dawn on May 10th. This was the signal for the French and British to advance eastward into Belgium in accordance with the provisions of " *Manoeuvre Dyle.*" It also was the signal for the French Ninth Army to move up and occupy the positions of the " defensive area " behind the Meuse, west of the Ardennes. As the German attack progressed, its complexities resolved themselves (according to the Daniker analysis) into three points of main effort : (1) The overrunning of Holland,

* " Der Durchbruch über die Maas am 13 Mai 1940," by Lieut.-Colonel Soldan, *Militärwissenschaftliche Rundschau*, November, 1940.

† " Vom Durchbruch zur Einkreisung," by Colonel Daniker, *Schweizerische Monatschrift für Offiziere aller Waffen*, January, 1941.

which denied the British bases from which they might have operated effectively against the Ruhr area; (2) The reduction of Fort Eben-Emael, keystone of the Albert Line and vital to the defence of Belgium and Holland; and (3) The breakthrough along the Meuse which resulted in the separation of the Allied armies north and south of the Somme, and made possible the Cannæ in Flanders. So much for the Big Picture. This account now concerns itself exclusively with item (3), the breakthrough.

The area pertinent to the breakthrough is shown to relatively large scale on map. An estimate of the terrain over this area resolves itself chiefly into a consideration of the Meuse River and the Ardennes Forest. The river is about seventy yards wide, with a



current of perhaps six feet a second, and flows through a valley hardly 500 yards wide, which is partly wooded and partly cultivated. The Ardennes Forest, the general outlines of which are indicated on the map, consists of a heavily-wooded country so rough and hilly as to be classed as "mountainous" by western European standards. The Ardennes is deeply cut by streams (one of which, the Semoy, is not everywhere fordable), and is served by a road net which, while fairly dense, involves steep grades, weak bridges, and many defiles.

In one sense, the issue of the entire campaign hinged on the conclusions following respectively from the French and German estimates of the terrain of the Ardennes. The French, looking as always to World War experiences, considered the area to be " as completely

unsuited for large-scale operations as any area possibly could be." The Germans considered that the area offered great difficulties, especially to motorized movements. But they believed that with proper equipment, training, and planning the difficulties could be overcome. There was one further difference between the French and German views on the matter: the French made no secret of their conclusions, but the Germans gave no hint of theirs.

The Germans, believing as they did, and knowing that the French believed otherwise, decided to capitalize on the situation. "They (the Germans) felt certain that they could overcome the difficulties that would arise (in the passage through the Ardennes), and that the French High Command, relying upon the difficulties of the terrain, was certain to be taken by surprise." Thus, a breakthrough over the Ardennes crystallized in the mind of the German High Command.

An estimate of the forces opposing each other in the breakthrough operation is as illuminating as the comparison of the estimates of the terrain. There has been no revelation as to the detailed composition of the German force ("We are still at war," says Colonel Soldan); but evidence as to its general characteristics is at hand. In this connection, reference should be made to the map. The breakthrough force formed the spearhead for the group of armies commanded by General von Rundstedt. The breakthrough force itself appears to have been a single army, commanded by General von Kleist. In the von Kleist army there were two corps, commanded respectively by Generals Guderian and Reinhardt. These two names —and especially the name of Guderian—were already famous in connection with the operations of panzer divisions in Poland. ("General Guderian," says Colonel Soldan, "has the temperament of a Zieten.") The name of the commander of the northernmost column shown on map is not known, although General Rommel has been mentioned in connection with an action in the vicinity of Dinant.

The breakthrough force was "completely motorized" and involved "a total of 45,000 vehicles." These facts, taken along with the knowledge that the Germans used perhaps ten panzer divisions in Poland, lead to the conclusion that the breakthrough force probably included at least eight panzer divisions, and possibly a few motorized divisions.

The dispositions of the French (according to Daniker, who depends on French sources), show far more eloquently than words the degree of their misplaced confidence in the barrier qualities of the Ardennes. These dispositions have been plotted schematically on map. The Second Army of General Huntziger occupied strong positions along the Meuse and Chiers Rivers from the vicinity of Flize to the northern extremity of the Maginot Line near Longuyon. Over this thirty-mile front General Huntziger had four divisions in line and

two in reserve. From the vicinity of Flize north to the Sambre River the line was held by the Ninth Army of General Corap.

More precisely, the line north of Flize was *to be* held by the Ninth Army of General Corap. The troops actually were in the positions along the Meuse only in the sector Flize—Revin, this fifteen-mile front being occupied by the " Mézières Fortress Division." Farther to the north the units of the Ninth Army were back on French soil, ready to advance to the Meuse when occasion demanded. When the occasion should demand, the respective divisions of the army were to be disposed about as indicated on the map. The fifteen-mile front Revin—Givet was assigned to one division. The twenty-mile front Givet—Namur, which covered an area considered to be more suited to motorized movements, was assigned to three divisions—the crack divisions of the army. Two divisions were in reserve, one behind the Ardennes and one farther to the north.

The situation east of the Meuse was relatively no better than that just described. The Ardennes were normally garrisoned by the Belgian *Chasseurs d'Ardennes*. These were supposed to be élite troops, but they were not well equipped—and there was only one division of them. The French Second and Ninth Armies were prepared to aid in the defence of the Ardennes—with five or six cavalry divisions. Each cavalry division was largely made up of horse units—four horsed regiments plus a few mechanized elements.

Referring again to the opening situation of the Ninth Army, it was more than a matter of that army being miles back of its Meuse positions when the German advance began, for the positions themselves were not strong and were not completely organized. German accounts mention " two lines of emplacements " along the river. But the French themselves regarded the sector north of Sedan not as a *region fortifié* (fortified region) but as *secteur defensif* (barrier zone). Perhaps the best commentary on the matter is the fact that the Ninth Army " counted on at least five days, and preferably six or seven, for the movement and organization of the position." If a nation's army ever staked everything on an estimate, the French army did so on its estimate of the time required for an enemy to traverse the Ardennes.

II

At 5.35 a.m. on May 10th, advance engineer elements of the panzer divisions of von Rundstedt's armies crossed over into Luxemburg and began removing and bridging over the road blocks (using no explosives for fear of damaging the roads). The main columns followed close behind. There was no resistance whatever, but " minor breakdowns and unavoidable friction " and " winding roads and weak bridges " reduced the rate of advance to below the time-table figures.

Within one hour and ten minutes of the time the Germans crossed the borders, orders to proceed with "*Manoeuvre Dyle*" came down the French chain of command. With this, the French and Allied forces in northern France began their eastward move. As has been indicated, the Second Army and the Mézières Fortress Division of the Ninth Army were already in position along the Meuse and the Chiers Rivers. The mass of the Ninth Army began to wheel about Mézières toward the Meuse. Simultaneously, the cavalry units of both armies were ordered into areas east of the river.

Thus, on the morning of May 10th, the immediate situation was about as follows: The German armoured units were rolling slowly westward, while the French cavalry units were trotting and galloping eastward. To a large extent the issue depended on the outcome of the meeting-delaying actions in immediate prospect.

The first of these actions occurred late in the afternoon when elements of the 2nd Cavalry Division encountered German armoured units in the long clearing west of Arlon. The result was a bitter fight lasting until dark. The French suffered heavy losses and were forced to withdraw. As the battered 2nd Cavalry Division fell back to the line Etalle—Neufchâteau, the 5th Cavalry Division was reported near Libramont. That was sometime after dark, May 10th.

Meanwhile the Germans were calling it a day. Their forward elements rested along a line just west of the Luxemburg—Belgian border. They were dissatisfied with the day's results, since the time-table had set the first day's objective as the line Libramont—Neufchâteau—Virton. Furthermore they were alarmed at reports received from air observers. These told of "strong enemy tank units" moving north-eastward from Carignan, Montmédy, and Longwy. It seemed that the strategic surprise so essential to the German plan had been lost—as well it might have proved if those reports had been correct. As a matter of fact, during the next morning the reports were found to be false. Between the panzer divisions and the Meuse there were only the Belgian chasseurs and the French cavalry.

While the cavalry of the Second Army had established contact with the enemy on May 10th, as already described, the cavalry of the Ninth Army, far from gaining contact with the enemy, had not even crossed the Meuse in force on that day. This failure of the cavalry of the Ninth Army to advance promptly had left the left (north) flank of the 5th Cavalry Division wide open. During the night of May 10th-11th, General Corap was ordered to get his cavalry forward, and quickly. As a result of the prodding, the morning of the 11th found the 3rd Spahi Brigade (Arab cavalry) of the Ninth Army in direct contact with the 5th Cavalry Division of the Second Army. The other cavalry divisions of the Ninth Army (the 1st and the 4th) had reached the area north and northwest of St. Hubert.

About 11.30 a.m. on May 11th, the 3rd Spahi Brigade and the 5th

Cavalry Division were struck by armoured units at several points between Neufchâteau and Libramont. Again the fighting was bitter, especially in the clearing between Betrix and Paliseul (where the fighting in 1914 also had been bitter). Again the French cavalry was forced back, withdrawing to behind the Semoy River. The time was about 5.30 p.m. The bridges over the winding, steep-banked Semoy were blown, and shortly afterward elements of General Guderian's corps occupied Bouillon. Those elements had driven through the allegedly fortified defiles near Neufchâteau with ridiculous ease, and without having to resort to the carefully rehearsed flanking operations which the time-table had assumed would be necessary. Meanwhile, with the Germans in Bouillon, the 1st and 4th Cavalry Divisions had no business out near St. Hubert. Accordingly, about 10.0 p.m., General Corap ordered those units to withdraw behind the Meuse. Neither division had yet been engaged. (There are no details regarding the activities of the Belgian chasseurs on this day of May 11th. Colonel Soldan intimates that the Belgians, utterly surprised at the rapidity and power of the German advance, were overrun without developing much resistance.)

The course of events on the 12th consisted once again of futile efforts on the part of the French cavalry to stem the advance of the panzer units. Out in front of the Ninth Army, the 1st and 4th Cavalry Divisions began their withdrawal toward the Meuse at 2.0 a.m., and carried it out by occupying successive positions. One such position, a few miles east of the Meuse and " far to the north," was attacked suddenly during the morning. Later, it developed that the surprise attack had been made by the " Ghost Division " of General Rommel, whose unit had acquired its nickname through just such operations as this one. However, the withdrawal could now be partly covered by French artillery west of the Meuse. By 2.0 p.m. (still May 12th), all cavalry of the Ninth Army was back behind the Meuse, and the order to blow the bridges had been given.

Farther to the south, near Bouillon, the story was much the same. There, the German tanks forded the Semoy at many places, and the French cavalry continued its precipitous withdrawal. During this day, German dive-bombers made their first appearances. The effects were great, both from the material and the moral points of view. The French artillery had now joined in the battle and occasionally a French bomber was seen. These individual French aviators had no effect on the general issue, but at one time they made things so hot around General Guderian's headquarters as to compel him to move to a new location.

By nightfall of the 12th, leading German elements had reached the heights overlooking the Meuse valley, and here and there a sharpshooter was trying his luck at picking off targets on the far bank. The long armoured and motorized columns stretched back

over Belgium and Luxemburg all the way to Germany. At General Kleist's headquarters there no longer was any gloom. The time lost during the first day had been redeemed by the speed with which the Neufchâteau and Semoy areas had been forced. The counter-attacks by French armoured units which had been so much feared had not materialized. The strategical surprise that was so important had been achieved.

At German headquarters, the big question now (night of May 12th-13th) revolved around the decision on the exact time for forcing the crossings of the Meuse. There was some question of delaying the attack until " the type of preparation which had always been considered essential for such an operation " could be made. It might have been especially desirable to have waited for the heavy artillery to be brought up. On the other hand, " it was realized that hesitation and delay would result in diminishing surprise," and since " successes achieved had strengthened confidence," the decision arrived at was to force the crossings the next day.

Across the river the French were in a bad way. This was especially true of the Ninth Army. Instead of the five days that army needed for organizing its positions, it had had barely three. Indeed, it is probable that, at some points along the Meuse, the Germans reached the east bank before elements of the Ninth Army had come up to the west bank.

III

During the 13th, crossings were forced at several points over the forty-mile front from south of Sedan to north of Dinant. At several other points, attempts at crossings were made, but were unsuccessful. The locations of these various points, in so far as they have been identified, are indicated by arrows on map. It may be noted that the chief crossing points are near Sedan, where it was necessary to cross the Ardennes Canal very soon after crossing the river. This disadvantage of the crossings near Sedan was considered to be more than outweighed by the superior road net leading to the west from Sedan, and the northward curve of the river below Sedan, which favoured the attackers as regards supporting fire.

" Little Picture " data concerning a few of these crossings of the Meuse are available. These data are summarized in the accompanying tabulation at the foot of page 314.

Following the first crossings during the evening of May 13th and the night of May 13th-14th, there was great activity on both sides of the line. The Germans were throwing everything into their attempts to strengthen and deepen the bridgeheads, looking ahead to the counter-attacks which they knew would be coming. By 8.0 p.m., on the 13th, armoured units (apparently set across on 16-ton ferries) had gained

the critical observation points near La Marfée and had disorganized the French 55th Division on the left flank of the Second Army.

The French, on their part, spent the night of May 13th-14th frantically assembling reinforcements and preparing defences and counter-attacks. The Ninth Army was being hard pressed north of Dinant; but it was apparent that the most dangerous breakthrough was the one near Sedan. Here, the German thrust had penetrated the line almost exactly at the junction of the Second and Ninth Armies, thereby jeopardizing both of them. During the night the two armies were able to scrape together reinforcements as follows:

Second Army: 5th Cavalry Division, which had been reorganized after its reverses in the Ardennes.

Ninth Army: 53rd Division, which was still fresh; and 3rd Spahi Brigade, which had been reorganized after its reverses in the Ardennes.

May 14th was a day of hard fighting, and of continued German successes. Based on details available, the following is a list of the major events of that critical day:

The 5th Cavalry Division and the 3rd Spahi Brigade were annihilated.

CROSSING AT	DESCRIPTION	REMARKS
Floing (Glaire-et-Villette)	505th Engineer Battalion (army troops ?) bivouacked near Bouillon night of May 12th-13th; advanced to "woods north of Sedan" early on morning of May 13th; bridge train (45 yard, 16-ton equipage ?) was with battalion; advanced through Floing to river bank on afternoon of May 13th; established 16-ton ferry at 5.30 p.m., May 13th; assisted by 37th Engineer Battalion (armoured division) completed 16-ton pontoon and trestle bridge (capacity at least 25 tons) at midnight, May 13th-14th; disassembled pontoon and trestle bridge (after "bridge construction battalion" had built fixed bridge) on or about May 19th.	This was the first pontoon and trestle bridge completed across the Meuse; it was used by the neighbouring division which crossed on May 14th and flanked out defenders who had prevented a crossing at Donchery; General von Rundstedt watched construction of the bridge.
Monthermes	57th Engineer Battalion (armoured division) cleared roadblocks in face of enemy small-arms fire at points a few miles east of Meuse on the afternoon of May 13th; reached river that afternoon, ferried across infantry and infantry weapons (including AT guns) in pneumatic boats after and under cover of dive-bomber and artillery bombardments; completed construction of 16-ton pontoon and trestle bridge on May 14th; meanwhile, assisted infantry in reducing "two lines of emplacements" at the rate of one line per hour, using flame throwers; battalion advanced behind division, was rejoined by bridge train at Artues in Flanders on May 29th.	This crossing, unlike those farther north, placed the attacking troops west of the Ardennes Canal.
Houx (north of DINANT)	(see page 319)	

The 53rd Division was thrown back on Ormont.

The Guderian columns, advancing south between the Meuse River and the Ardennes Canal toward the high ground at Stonne, were attacked by strong French forces, partly armoured. After heavy fighting, the French attack was repulsed.

Elements of the Guderian columns, turning sharply to the west, captured two important bridges over the Ardennes Canal (at Omicourt and Malmy) before the French could demolish them.

One panzer division, unable to force the crossing at Donchery, sent units over the bridge at Glaire, two miles upstream, and took Donchery from the rear. (The Donchery bridge was finished by midnight, May 14th-15th.)

Units crossing over the captured bridges of the Ardennes Canal turned north and occupied Flize, thus exposing Mézières-Charleville to envelopment from the rear.

Additional reinforcements for the Ninth Army, consisting of the 1st Armoured Division and the 4th North African Division, arrived respectively at Charleroi (by train) and Philippeville (on foot)—too late and too far away to be of help on this day (May 14th).

Extreme left flank of Second Army was further strengthened and fell back slowly on Stonne.

General Corap, commander of the Ninth Army, decided to abandon the line of the Meuse, and to withdraw during the night of May 14th-15th. Withdrawals were to be to two lines. The troops between Mézières and Fumay were to fall back to the line Signy-l'Abaye—Rocroi—Couvin, while those north of Givet were to withdraw to the line Merlemont—Florennes—Mettet.

On the morning of the 15th, there remained no doubt as to the magnitude and seriousness of the breakthrough. On the northern shoulder of the gap, the French 5th Division with parts of the 4th Cavalry Division in support, was holding fast, with its left on the Meuse south of Namur, and its right bent back towards Florennes. On the southern shoulder, the left of the French Second Army was bent back on Stonne. Between Stonne and Florennes, the elements of the Ninth Army were in process of disintegration.

Thus, between Mézières and Fumay, the front-line units had not been able to withdraw as General Corap ordered; and on the 15th those units were being attacked on all sides. During the night, the "badly decimated" 18th Division, supported by the fresh 4th North African Division and the 22nd Division, attempted to reorganize and assemble in some unidentified area "12 miles west of the Meuse." During the night (May 14th-15th) the 1st Armoured Division had come up and had assumed a "battle formation" along the line Flavion—Ermeton. The battle formation consisted of two lines of tanks, heavy ones in front, light ones in rear. (The better expression would be to use "east" and "west" in place of "front" and "rear,"

since by now there was no telling the direction from which an attack might come.) And as a last straw, the armoured division ran out of petrol.

There is no record of the armoured division having actually figured in a fight, despite the battle formation. The German units appear to have slipped by to the south of Flavion. Later in the day (still May 15th) they barely missed capturing General Corap near Froidechappelle. At about the same time, the general commanding the 18th Division had a similar narrow escape near Beaumont. These things show the depths at which the panzer units were already operating.

During the 15th, the Reinhardt column, which had crossed at Monthermes on the 13th, but which had been held up by difficult terrain and strong resistance, broke through to Arreux. In the course of this advance, the French 61st Division was all but wiped out. The advance to Arreux also made untenable the French positions which until now had prevented a crossing at Nouzonville. From Arreux, the Reinhardt column pushed forward rapidly, occupying Liart probably late on the 15th. At the same time, certain of the Guderian forces pushed the left of the Second Army back on Stonne, while the rest of the corps continued the advance to the west.

By nightfall of May 15th, the Ninth Army could no longer be considered capable of offering serious resistance. The army had been completely defeated. The sector it had occupied until two days before was now a gap fifty miles wide through which the German armies poured. By May 16th, the Germans held the line Vervins—Montcornet—Rethel. Four days later, the corridor had been driven to the sea, the encirclement of the armies in Flanders was complete, and the framework for the Battle of France—including bridgeheads over the Somme—had been established.

IV

Up to this point, the effort has been made to keep this account strictly reportorial. Actually, the Soldan and Daniker articles are full of comments and conclusions (not to mention a bit of propaganda now and then). Those of especial interest are summarized below:

The Lessons.

Both Colonel Soldan and Colonel Daniker agree that the great lesson to be derived from the breakthrough operation has to do with the capabilities of the motor-air combat team. In this respect, they pronounce the operation to be of history-making significance, marking as it does "the first instance in history in which motorized

units supported by aircraft have attained a large-scale strategic success against a major enemy." In the new combat team, "motor joins motor, and speedy ground movement is covered by a rapidly moving curtain of the most intense kind of artillery fire." This is a principle "upon which many a military success hereafter will depend."

Colonel Soldan deplores the tendency to consider armoured forces as "modern cavalry." The analogy has some substance if the reference is to the cavalry of Frederick; but none if the reference is to the cavalry of the World War. Unlike the cavalry of "earlier days," the armoured force has the ability "to fight and win battles in complete detachment from all other *ground* troops." This ability derives from the facts that the armoured force "includes all types of weapons within its own organization," that its "mobility and speed add greatly to the effect of these weapons"; and, that it makes full and unique use of the tank. Incidentally, the tank if used alone would come close to fitting the expression "modern cavalry"; but without support from the air, the tank would lose much of its shock power.

In one important respect, the armoured force of to-day and the cavalry of old are alike—the type of leadership required. Just as Frederick had his Zieten and Seydlitz, von Rundstedt had his Guderian and Reinhardt.

Daring, speed, and surprise are the basic elements for a successful breakthrough. The breakthrough itself consists of a series of overlapping operations: the penetration, the widening and deepening of the gap, the constant forward movement, the continuous flow of new strength through the gap. The failure of any one of the contributing actions will compromise the chances of success for the operation as a whole. Thus there is need for the most careful study and planning before the operation is undertaken, and this "is especially true of motorized troops." In the breakthrough along the Meuse, "each movement was carefully calculated, and orders anticipating every situation that could possibly be foreseen were given in advance."

Thorough and appropriate training is as important as careful planning. "Every man, down to the last driver, must be trained to the point where he has a full mastery of technical details and the ability to combine calm and resourceful thinking with a high degree of initiative under fire." Colonel Soldan intimates that this criterion for training was satisfied by the German troops, but as evidenced by "the nature of their retreat and the condition in which they left the roads," it was not satisfied by the French.

Colonel Soldan emphasizes the sensitivity of motorized columns to mishaps which in themselves appear small. Thus, the stalling of one vehicle may be "disastrous for the whole column," something

" our enemies in this war have more than once had occasion to confirm." Therefore the vehicles of motorized columns must be kept in good operating condition ; and as for " iron " march discipline, it " is nothing less than a matter of life and death." Incidentally, an advancing armoured force seizes all motor transportation abandoned by the enemy just as the infantry seizes abandoned equipment. The driver " makes it a practice to inspect every abandoned vehicle. For, no matter how badly the vehicle is damaged, there usually is some part—battery, spark plugs, tyres—which may be used to advantage." As it worked out in France, " lost cars were easily replaced from the thousands of vehicles—sometimes whole columns lined up ready to go—which the enemy was compelled to leave behind."

The actual crossings of the Meuse were taken by the panzer columns almost in stride. The rôle traditionally filled by the heavy artillery was filled by the dive-bomber. And the complete motorization of all units participating in the attack enabled new strength to be brought quickly forward. The crossings themselves were effected by tried and true methods: light (pneumatic) assault boats for the first waves; ferries, built on assault boats or pontoons, for vehicles, weapons, and tanks; and finally, pontoon and trestle bridges made from standard equipage for loads of all types.

Colonel Soldan comments on the failure of the French to interpret correctly " the signs of the times." Leaning on the teachings of history, they concluded that a river like the Meuse could be forced, but only after the attacker had " completed extensive preparatory operations especially as regards the bringing up of heavy artillery." Colonel Soldan gives a hint of the German idea of how such a river should be defended against armoured attack when he says that the French should have realized that " the use of an obstacle like the Meuse could easily be dangerous, and safety demanded that the defenders advance, fighting aggressively for the line of the river." Colonel Daniker observes that this was not the philosophy of General Gamelin, who believed that any army that "gave up its shell" would be defeated. Neither of the colonel-authors dwells long on the other elements of French weakness : the time required for them to occupy their positions, the lack of strength of the positions, the extended fronts of the divisions west of the Ardennes, the lack of mechanized means for counter-attack, the lack of air support.

It now appears that deeper study of the French weaknesses may somewhat narrow down the exceedingly broad conclusions some of us have arrived at too abruptly regarding the super-efficiency of the motor-air combat team.

(THE LITTLE PICTURE.)

A PANZER DIVISION CROSSES THE MEUSE.

(Reprinted from *Infantry Journal* (Washington), May, 1941.)

ON the 12th, 13th and 14th of May, German panzer units crossed the Meuse River at many points—and by several methods. Down south near Sedan, where the stakes were high and the crossing meant the breaking through of the main French line, the assault was preceded and covered by paralyzing dive-bomber action. But farther north, where the Meuse flows through Belgium and the main French line was miles to the west, there were few dive-bombers—and, of course, little or no artillery (the latter was absent, or nearly so, from all these blitz-crossings).

This brings us to the afternoon of Sunday, May 12th, and to a road junction a few miles east of the Belgian town of Houx-on-the-Meuse, northwest of Dinant. We are now located on the extreme right (northern) flank of the sixty-mile front along which the great break-through was impending. At the time and place in question, we pick up the advance guard of a certain panzer division. The exact composition of this advance guard is not known; but, it included tanks, scout cars, and motor-cycle infantry.

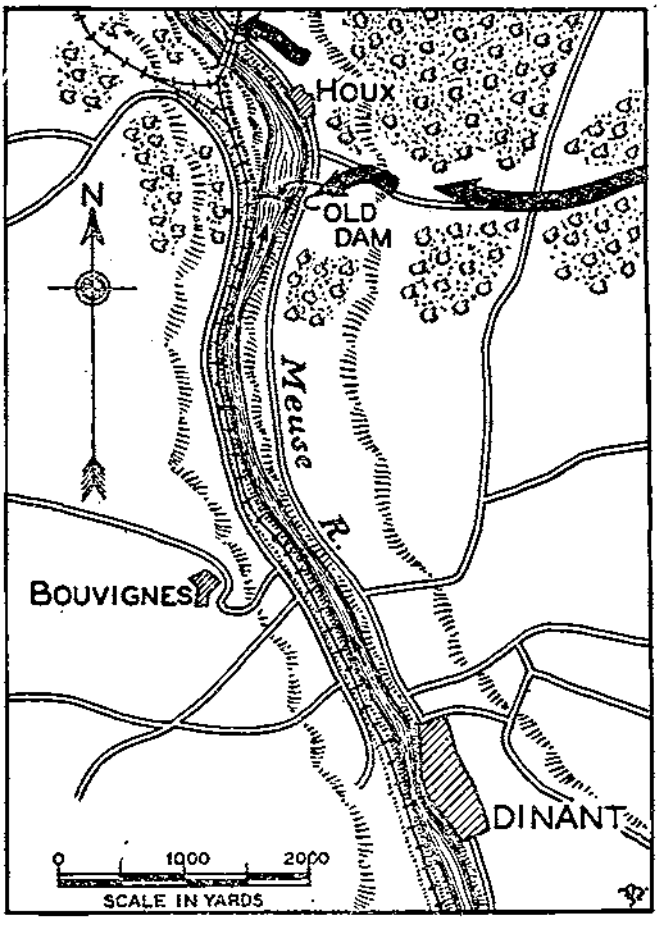
The advance guard had halted at the road junction (see map), and the commander had given his orders. The main part of the force, including all of the tanks, was to take the turn to the left. A small detachment, consisting of three scout cars and a platoon of motor-cycle infantry, was to move straight ahead, toward the town of Houx. This detachment is our immediate concern.

The scout cars, followed by the motor-cycles, rolled along through the deserted villages without incident but with "adequate security." When the road began to dip downward toward the valley of the Meuse the column reduced its speed and increased its caution. This is the point at which our chronicler (the commander of the motor-cycle platoon?), whose flair for the dramatic unfortunately is not matched by his attention to detail, describes the Meuse as "a deep moat, crossed only by draw bridges, all of them now drawn." As a matter of fact, the Meuse at Houx is about seventy yards wide, and lies in a narrow valley bounded by high rocky bluffs. Along the far (west) bank runs a railway embankment.

Dramatic description notwithstanding, one bridge across the "moat" remained intact and undrawn on this Sunday afternoon. It was the railway bridge at Houx, which stood there safe and sound and apparently undefended as our detachment drove into view of the river. This looked like a great break, and the scout cars were quick to take advantage of it. The first car had reached the centre of the bridge, the second was about ten yards behind, and the third

was still on the bank when—some Belgian engineer pulled the switch, and the explosion came. Steel, stone, cars, and crews went up into the air and down into the water. The Houx bridge had passed out of the picture as a factor in the German crossing of the Meuse.

As the two scout cars thus were being blown into the river and out of the war and this story, the motor-cycle platoon apparently had been under cover back near the bluffs. By this time, the Belgian



artillery had opened up and was dropping shells on the approaches to the far (eastern) bank. In this connection, the artillery of the great Meuse fortress of Dinant, south-west of Houx, was especially effective. Nevertheless, the panzer division continued to come up, and reconnaissance parties were active along the entire bank. One such party consisted of our motor-cycle platoon, now working its way afoot across the valley toward the river. The going was slow, inasmuch as any activity discernible to observers on the far bank brought bursts of machine-gun fire. Finally (it must have been

late afternoon), the reconnoiterers reached the river bank—and reached it exactly at the site of an old, low dam. Our chronicler infers that the existence of this dam had never been suspected, and that its discovery came as a great and welcome surprise. This inference may be questioned, inasmuch as even the 1,200,000 French maps indicate a lock at the point in question. In any event, the dam looked to be about to fall to pieces. Water was streaming through it as though through a sieve. It was in such bad shape that the Belgians apparently had not considered the possibility of its use in connection with a river crossing. But the Germans were considering that very thing.

Meanwhile, behind an embankment a few hundred yards to the rear, the colonel commanding the advance guard was busy sending out reconnaissance parties and receiving reconnaissance reports. After darkness had fallen, he gave his orders. The crossing was to be forced at Houx. The attack was to jump off at 5.30 in the morning. During the remainder of the night, reconnaissance was to be continued—and was to be extended to the far bank.

The troops assigned to the far-bank reconnaissance constituted an "assault detachment." The exact size and composition of this detachment is not recorded, but apparently it consisted chiefly of the motor-cycle platoon and a few engineers. The detachment moved out well-stocked with that distinguishing feature of German assault parties: the hand grenade. The soldiers must have resembled walking arsenals—hand grenades in bundles slung over the shoulders; hand grenades stuck into the tops of boots; hand grenades stuck between the buttons of blouses.

The detachment made its way slowly to the river, moving by bounds, and freezing in position whenever an enemy star shell burst overhead. The route had been planned so as to lead to the old dam. The idea was to use the dam as a footbridge for crossing over to the far bank. Arrived at the site, the detachment set up a few machine guns; and then the first man started across—"like walking a tight rope silently and in the dark."

Several of the troops got across in this manner, apparently without drawing enemy attention. As soon as a few of the troops had gathered at the far end of the dam, they started up the bank. The latter was steep, revetted, and rimmed by the railway embankment. The troops must have made considerable noise in climbing, since it was enough finally to awaken the defenders. Thus, as the Germans raised themselves above the embankment, they were met by strong machine-gun fire coming from guns close at hand. They hit the ground, and simultaneously their own machine guns on the other bank opened up. Bullets from the latter began ricocheting off the railway rails and ballast, just above the attackers' heads. Our chronicler admits that here was a situation beyond his powers of description.

Meanwhile, others in the assault detachment were now getting across. Some were walking the dam, and some were ferrying over in pneumatic boats. It is recorded that many of the boats were shot to pieces. But the chief danger along the dam route appears to have been the danger of losing balance. On the Belgian bank, the attackers were spreading out along the embankment, manœuvering slowly and cautiously. Finally they succeeded in bringing a few of their light machine guns into position. Details as to the fight in the dark which followed were not available, but eventually the most dangerous of the Belgian guns were silenced, and the Germans advanced over the embankment. They crawled forward over the fields for another 200 yards or so, and then decided to take up a position protecting their "bridgehead." This taking up of position consisted of each man digging himself a foxhole, or otherwise securing cover. At this time, there were several hours of darkness left (our chronicler is eloquent on the subject of how slowly they passed). So, by switching back to the German bank, we will be in time to catch the main crossing scheduled to begin at 5.30 a.m.

Throughout the night the Belgian artillery had continued to pound likely assembly areas on the German bank. In spite of this, preparations for the crossing, including the bringing forward of bridging and ferrying equipment, appear not to have been greatly disrupted. However as morning approached nature herself introduced a new element in the form of a thick fog which settled over the valley. This fog enabled the Germans to move about on their bank free from direct enemy observation.

It appears that everyone was expecting, or at least hoping for, a swift and easy crossing. However, as the first assault boats started across, the Belgian machine guns opened up along what must have been their final protective lines. The assault boats were stopped. Also stopped was an attempt to cross by footbridge (although, peculiarly enough, the bridge itself was laid and maintained successfully). Things now were looking bad.

At this critical moment, there appeared on the river bank none other than the commanding general of the division. He had come forward (says our chronicler) the hard and dangerous way, crawling and freezing and bounding and taking his chances just like any other soldier. The general saw that the crossing was to be no set-up, and that what was needed was some supporting fire. His reaction to that conclusion forms perhaps the most interesting aspect of this whole action, and provides us with an example of how the tanks of panzer divisions are often used to cover and support the advance over obstacles of other elements of the division.

The general's reaction was to order some of the medium tanks to positions close to the river bank. At this time, the fog was lifting but visibility still was poor. The tanks came up, took positions, and

opened with machine guns and cannon on the enemy machine guns which were holding up the assault crossing. Under cover of this fire of the tanks, the crossing attempt was resumed, and this time was successful.

The crossing operation was still in its early phases when a new menace developed, consisting of Belgian tanks, reported to be sweeping down from the north obviously with a view to snuffing out the bridgehead before it could be consolidated. So far, no rafts had been put in operation, and as a result only infantry and infantry weapons had been put across. It looked as if there was nothing with which to stop the tank attack.

Here again the general had the answer—had it in the form of a stratagem which would read more appropriately in *Terry and the Pirates* than in *Militärwissenschaftliche Rundschau.* The general ordered the infantry to open fire on the advancing tanks—with flare pistols. The order was carried out. And so, as the tanks advanced through the mists, the crews saw themselves under the fire of projectiles which left fiery trails over flat trajectories. According to our chronicler, the Belgian crews thereupon concluded (as the general said they would) that they were running into a mass of anti-tank guns which at the moment were sighting in with a few tracer rounds. Thereupon, the tanks turned and left the field (as the general said they would).

The affair of the flare pistols and the tanks marked the last important crisis in the crossing operation. During the course of the morning, the engineers got several vehicular ferries in operation, and began setting across tanks, vehicles, and heavy weapons in a steady stream. Meanwhile, the construction of a pontoon bridge was begun, and was completed in due course, even though the engineers occasionally had to lay aside their tools and add their fire to that of the anti-air batteries against low-flying enemy planes.

(As the first assault waves got across and pushed forward, they passed over (probably to their surprise) the reconnaissance party which we left in its foxholes the night before. Our chronicler is at his eloquent best in describing the way in which this reconnaissance party had held its ground throughout bombardment, and counter-bombardment. But on the subject of just what purpose was served by all this, he is eloquently silent.)

THE OIL SITUATION IN THE MIDDLE EAST.

By "OILFIELD ENGINEER."

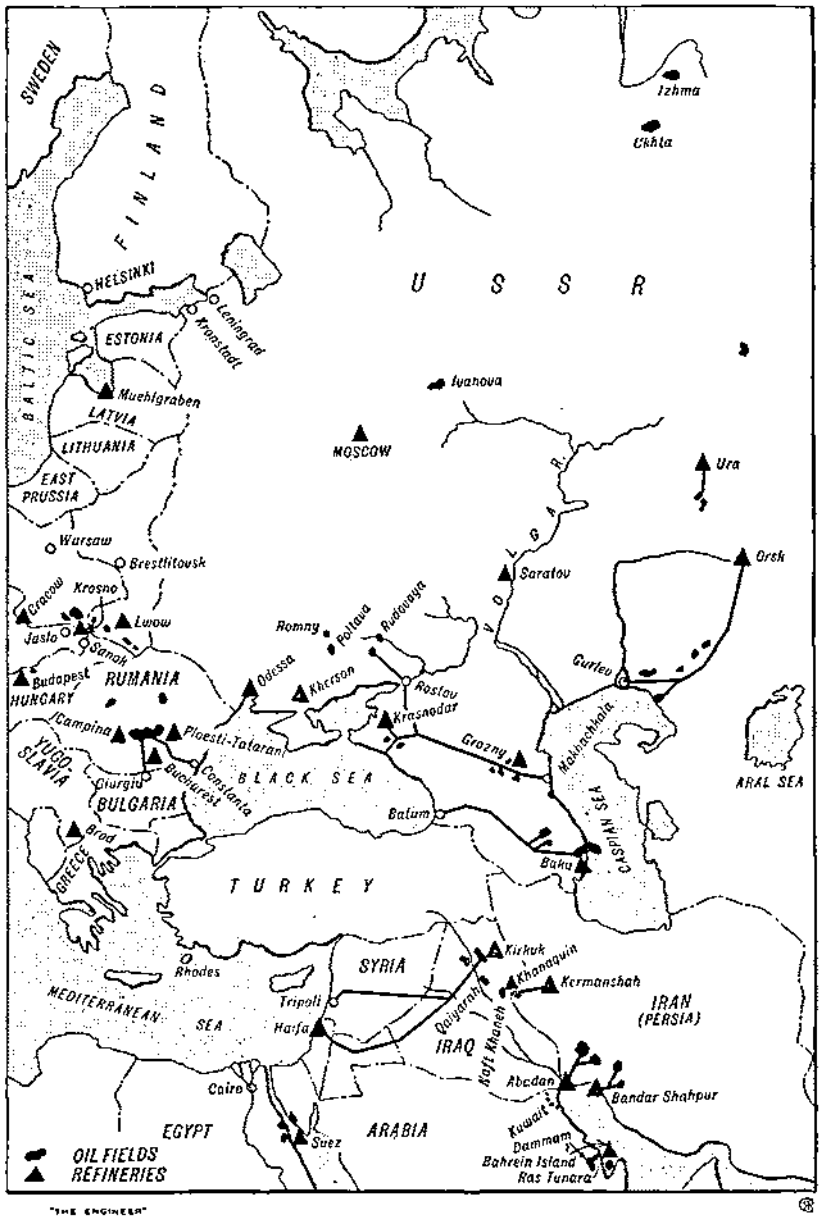
(*Reprinted by permission from "The Engineer" of 23rd May, 1941.*)

WHEN considering the oil situation in the Middle East, especially in Irak, one has to depend very much upon newspaper reports. Comments with these reports inevitably refer loosely to oil, as if crude oil, produced in the various oilfields, were a commodity available for use immediately on the spot. Crude oil must be refined before it can be used, and the refineries in all parts of the Middle East are easily rendered completely useless, either by bombing from the air or by demolition by ground staffs. When this important point is appreciated properly, the situation loses much of its unfavourable aspect, and newspaper comment is shown, almost invariably, to be ill-informed and unduly alarming in character. To make use of the oil resources of the Middle East, even should the Nazis continue their conquering progress to Irak, Iran, Egypt, and Russia, the crude must be refined. With the refineries all destroyed, and the pipe lines irreparably damaged, the Axis Powers would have either to transport refinery equipment from Europe over a long and difficult route, to be erected in the actual oilfields, and thus provide fuel and lubricants for their forces and aircraft on the spot, or they would have to rebuild pipe lines and gain command of the Mediterranean, to transport the crude to European refineries, which may or may not be left standing after R.A.F. bombing attacks.

A glance at the sketch map will show the distances to be traversed for either alternative to be practicable. When it is remembered that the Nazis are hard put to it to repair their own refineries, owing to restricted output of refinery equipment in European countries, and that they lack the necessary huge output of line pipe for new pipe lines, the considerable and complicated equipment for laying pipe lines, and the experience on pipe line work, together with there being no possibility of obtaining the services of expert American pipe liners, any oil man who knows his job has the right to question the Axis strategy which, apparently, will cost great numbers of men and considerable effort to gain control of Middle East oilfields. These fields will produce crude oil, if drilling and producing equipment is available for the purpose, but they will not, owing to lack of refineries, make fuel and lubricants available to the Axis armed forces either on the spot or in Europe.

Having made these important points clear, we may study the various areas in which crude oil is produced.

Irak.—Competent American sources estimate Irak crude production in 1940 to be around 10,000 tons per day. The majority of this



production comes from the Kirkuk field, which is one of the largest producing areas in the world. This field is about 65 miles long by an average of about 2 miles wide, and approximately sixty wells have so far been drilled. Many of these wells are each good for a pro-

duction of more then 10,000 tons per day, but for various reasons the output is restricted. The Kirkuk crude is around 36 gravity A.P.I.—a fairly good grade of crude, and is produced from formations at 2,100 ft. to 2,200 ft. One of the gratifying features of the Kirkuk field is that there is a very small pressure differential. Wells when flowing wide open for short periods on test, compared with those shut in, show a pressure of 13 lb. per square inch as against 20 lb. per square inch. Development of the field has been very scientific, and nearly all the present production is piped through the line from Kirkuk to Haifa. This line is bifurcated near the Syrian border, but after the collapse of France no crude went through to Tripolis on the Syrian coast, where a small refinery treated the small stocks of crude held in storage tanks there.

The restriction of pumping crude only to Haifa has caused a drop in total production.

Before pumping the crude from Kirkuk to the refinery at Haifa, it has to be treated in a stabilization plant, designed to remove the high content of hydrogen sulphide. This stabilization plant—which is not a complete refinery—has a capacity of more than 10,000 tons per day, and the capacity of this plant, until the French defection, restricted the total crude volume pumped through to the Mediterranean.

The Haifa plant undoubtedly produces most of the fuel and lubricants required by our forces in the Mediterranean areas of Africa and Palestine. The success of the Nazis in Greece places the Haifa plant in a rather precarious position, however, as it is within range of bombers operating from the Greek air bases.

Should we be forced to evacuate Palestine as the result of a Nazi drive through Turkey or *via* the many islands of the Eastern Mediterranean, we may be sure that the Haifa refinery and the long stretches of the pipe line towards Kirkuk will be destroyed by our ground forces. But it must be remembered that the loss by bombing or enforced evacuation of the Haifa plant is not vital, as Egyptian refineries can supply considerable quantities of fuel and lubricants, whilst we have production of the Bahrein refinery, Burmah, Iranian, and even Dutch East Indies plants available, so long as we keep command of the Indian Ocean and of the Red Sea.

The former B.O.D. field at Qaiyarah, 75 miles south of Mosul, on the banks of the Tigris, has a potentially great production, but the crude oil is of poor quality, being less than 20 gravity A.P.I., with a content of more than 6 per cent. of sulphur. The Qaiyarah field is about 23 miles long by an average of 2½ miles wide, and about sixty wells have been drilled there. Production is very restricted, owing to the poor quality of the crude, and to the limited facilities of the Irak pipe line carrying the higher grade Kirkuk crude to Haifa. Production at Qaiyarah is estimated to be less than 13 tons per day, and this oil is used only for local fuel and road oil requirements. The oil is

produced from the Asmari limestone, at depths of 700 ft. to 1,500 ft.

Naft Khaneh, just over the border in Irak from Iran, was formerly in Persia until a new line of demarcation between these two countries was drawn after the last war. Production here is less then 60 tons per day, which includes production from the small field of Chia-Surkh. The oil from these two fields is piped to the refinery at Khanaquin (Aldwan), which has a capacity of about 360 tons per day.

The only other refinery in Irak is that at Baba Gurgur, with a capacity of slightly more than 200 tons per day. This plant treats crude from Kirkuk for local requirements.

This survey of Irak indicates quite clearly that although crude oil production is now restricted, the potential production is great. But the Irak crude could not be transported to European refineries for treatment until complete command of the Mediterranean was obtained, and the time taken to lay new pipe lines or to repair the damaged line now operating would be so long, owing to the factors already detailed, that the Irak crude would be of no military value to the Axis, even if new drilling and producing plant were transported from Europe for resumption of production.

Egypt.—Egypt has not received much limelight from the point of view of oil. This country has, however, considerably increased exploratory activity during the past few years, with encouraging results. Again in 1940, production was increased by 50 per cent., and Hurghada and Ras Gharib are the two main producing fields. The crude has a gravity of 36 A.P.I. at Hurghada and of 38 A.P.I. at Ras Gharib. There is a large and a small refinery at Suez. These plants play an important part in the supply of refined products to our Near East forces. Ras Gharib is a field capable of greater production, and refinery capacity in Egypt will undoubtedly be increased in the future.

Iran.—The Anglo-Iranian Oil Company, Ltd., in which the Government has a considerable interest, operates one of the richest concessions known in the oil world.

The 1940 production totalled about 11,000,000 tons, as against a slightly higher figure for 1939, but this volume does not represent more than a fraction of potential output. The southern fields of Masjid-i-Sulaiman—first exploited in 1908—and of Haft Kel, 50 miles south of Masjid-i-Sulaiman, are both connected by pipe line to the huge refinery at Abadan, on the Persian Gulf. Abadan has the largest capacity of any refinery in the Near East. Other fields in southern Iran, at Lali, Agha Jari, and Gatch Saran, have been developed, with excellent potential output in each case. The northern field of Naft-i-Shah produces crude refined at Kermanshah, where the plant has a daily capacity of about 430 tons, and a pipe line connects Naft-i-Shah with the refinery. The fields of Naft Khaneh and Chia Surkh, in Irak, are just across the Iranian border from Naft-i-Shah.

White Oil Springs is another northern field, being about 10 miles south of Haft Kel. Drilling depths range from 1,500 ft. in Masjid-i-Sulaiman to 8,000 ft. in the new field of Gatch Saran.

Another refinery, at Bandar Shahpur, on the Persian Gulf, with a daily capacity of over 7,000 tons, refines some of the crude production from the Southern Iranian oilfields.

Iran is reported to be infested with the inevitable Nazi "tourists," but here, again, should the Axis gain control of the country, the pipe lines and refineries would be easily destroyed by ground staffs, with the result that advancing troops, whilst finding copious supplies of crude oil, would not be able to obtain usable products without the necessary refineries.

Arabia.—This sector of Asia has come in to the oil picture very prominently during the past few years, with the discovery of oil on Bahrein Island. The 1940 production here was over 1,000,000 tons. The oil is found at depths of 2,000 ft. to 2,250 ft. and of 4,000 ft. to 4,600 ft., with a gravity of 33.5 A.P.I. More than seventy wells have been drilled, but production is restricted owing to insufficient refinery and transport facilities. A very large refinery is operating on Bahrein and drilling on this island has assisted surveys on the Arabian mainland. Bahrein is of great strategical importance to us, and has been bombed by Italian planes, on one occasion, so far.

Saudi Arabia has been the scene of considerable activity during recent years, and Damman has a production of nearly 4,000 tons per day. A pipe line runs from the field to Ras Tunara, on the Persian Gulf coast.

Further up the Persian Gulf, adjoining Irak, Kuwait, an independent Sheikhdom, is the scene of oil activity. The town of Kuwait is about 110 miles across the desert from Basra, and the producing area of Burgan is about 30 miles distant from the town of Kuwait. Potential production in Kuwait is considerable, as many wells are believed to be good for over 700 tons daily production each. The oil is of 34 gravity A.P.I., and is found at depths of 3,500 ft. to 4,500 ft. Original exploratory drilling in the Bahrah area of Kuwait was abortive, after drilling had been carried down to over 8,000 ft. The Kuwait area is another indication of the potentialities of Arabia as an oil producing country.

Russia.—This country is included in the discussion, as its oilfields really come into the Middle East area. Lack of definite news from Russia makes it difficult to give a complete picture of conditions of the oil industry there, but sufficient details are known to enable comparatively accurate estimates to be made.

In 1939 production of crude oil in Russia was estimated by competent observers with knowledge of Russian conditions to be about 4,433,000 tons, and 1940 should have shown an increase on this figure.

The main producing area is in the Caucasus, especially around

Azerbaidjan, Mirzany, Siazan, Baku, and other fields on or near the Caspian Sea. A little further north the well-known fields of Makhachkala, Grozny, Malgobek, Hadyzkinsk, and Maikop continue production, with exploratory drilling showing good indications.

Drilling in the north-east of the Ukraine, at Romny and Poltava, has resulted in production, whilst the Ural-Volga regions have been developed with satisfactory results. In the north of the Ural-Volga area, near the Barents Sea, oil has been found at Izhma and Ukhta, whilst a new field at Ivanova, north-east of Moscow, has been opened. Much work has been done to increase production from the older oilfields in the Caucasus, by scientific development of old wells, and the finding of new production at lower levels, especially in the Azerbaidjan district. Russia has control of some of the former Polish oil areas, east of the San River, in the Lemberg area.

In spite of the fact that during 1940 more than double the exploratory work of 1939 was effected, Russian oil output is reported to be well in arrears of the volume aimed at in the current Russian Oil Plan. Lack of modern equipment is really responsible for this state of affairs, and in the latter part of 1940 the Russians ordered rotary drilling equipment to a total value of over 2½ million dollars. It was the ordering of these vast quantities of equipment, with more purchases contemplated, which caused the President of the United States to insist on export licences being obtained for the export of all drilling and general oil equipment from the States after February 3rd, 1941. Whilst it is known that Russia needs quantities of new drilling equipment, it is quite possible that re-export of such equipment to Germany was feared, and a curb on any such eventuality arising was effected by the new U.S. export licence regulation.

The majority of the Polish estimated output of over 7,000 tons per day is under the control of the Russians, and this production would be a useful addition to the resources of the Nazis should they have found them intact. There are many refineries in the oilfield areas of Lemberg (Lwow), and it is to be hoped that the Russians effected total destruction of drilling, production, and refinery equipment in Poland when the Nazis' advance began.

A drive through the Ukraine down to the Caucasus by the Nazis is expected, but the Russians would surely have plenty of time in which to destroy drilling and production equipment in the oilfields. There are pipe lines connecting Baku, on the Caspian Sea, with Batoum, on the Black Sea, with connecting lines from the southern Caspian oil area and the inland fields of Mirzany, Shiraki, etc. Another line runs from Makhachkala, through Grozny, Maikop, to Tuapse, on the Black Sea, with a fork up to Trudovaya, in Eastern Ukraine, *via* Rostov-on-Don. The refineries at Baku, Grozny, Krasnodar (near Maikop), Odessa, and Kherson in the Caucasus and Ukraine are easily destroyed, and it may be assumed that the Russians are rendering any of their oilfields and refineries that may be overrun completely useless, otherwise the Germans will gain

supplies of much-needed refined products. Transportation of Russian crude from the Caucasus to Rumanian and other European refineries would occur only if the pipe lines were left intact, and the destruction of these lines would make it virtually impossible for the Nazis to make use of the crude oil resources of Southern Russia. There are other refineries at Moscow, Seratov (on the Volga), Ura, and Orsk, which are well away from the theatre of war, as are the Ural-Caspian oilfields.

CONCLUSION.

From this discussion regarding the oil resources of the Middle East the reader will appreciate that there are tremendous supplies of crude oil, which may fall into the hands of the Nazis. If, however, normal precautions are taken to destroy the many pipe lines and refineries by ground forces before evacuating areas rendered vulnerable by advancing enemy troops, the Axis Powers will lay hands on plenty of oil, as crude oil, but will be unable to transport the crude to refineries, or to build pipe lines to points from which crude may be shipped to European refineries.

The difficulties of the Nazis in the obtaining of oilfield equipment and of refinery equipment are well known, since factories for the manufacture of such equipment are not numerous in Europe. Japan was used in the last part of 1940 by the Nazis as a purchaser of drilling equipment from the States. No less than 281,437 dols.' worth of drilling equipment was bought by Japan in December, 1940, and the Japanese oil industry cannot, under any circumstances, make use of such a large quantity of material, especially when one considers that the normal Japanese purchase of this equipment is only some 60,000 dols. per year. These purchases were another factor deciding Roosevelt to issue export licence regulations, and this channel of oilfield equipment supplies to the Nazis is now closed.

It is hoped that this fully detailed analysis of the oil areas of the Middle East will convince the reader that, although the Nazis may be able to conquer oil-producing countries, the use of the crude oil of such countries depends entirely upon refining facilities, and that refineries, pipe lines, and oilfield equipment—all very easily damaged —cannot be replaced by the Nazis because they have not sufficient manufacturing facilities for such materials, and the distances involved in transportation of such materials, even if available, are enormous. It would take years of untroubled effort to make use of the crude oil of the Near East, and it is hardly to be expected that we should refrain from attacking vulnerable transport points on the Nazi's lines of communications, and thus permit him to develop refineries and pipe line facilities in the conquered oilfield areas.

BARRIER TACTICS.

By MAJOR L. E. SEEMAN, *Corps of Engineers, U.S.A.*

(*Parts of an article reprinted from The Military Engineer (Washington) of May-June*, 1941.)

CONSIDERABLE attention in the news of European military events has been directed upon those most visible of defensive measures—structures—both in the nature of frontier blockades and fortifications. These structures, however, seem to have resulted in little delay to the advance of the German forces. Was the elaborate construction of barricades a waste of time and money? Was there faulty planning or operation of the structures? Reports from observers told of special barrier troops. Did these troops imply a new creation necessary to offset the increase in armoured forces? Was there a gap in our military knowledge, or were our combat arms fulfilling the missions of barrier units without being specially designated?

The subjects of barrier tactics and anti-mechanized defence in our military terminology are so closely related that distinction between them is difficult. Both subjects are studied for the same purpose; namely, to reduce the danger to a command from enemy armoured forces. The commander is applying the principle of security in either case.

Generally speaking, the application of these tactics to the protection of front and flanks and to the filling of a gap between units is well established. Security against modern armoured vehicles used in mass, however, demands the extension of the use of barriers and barrier tactics to the entire theatre of operations. No single barrier of whatever strength can be considered impregnable to a determined assault. Provision must be made *in advance* for dealing with possible penetrations by masses of armoured vehicles. The single barrier line can be no more reliable than the single line of any defensive system.

Barrier operations are defensive in character, but it does not follow that their use necessitates the abandonment of active measures. A barrier is simply a security measure which may enter any form of operation and in no sense does its use imply the surrender of the offensive principle.

THE REAR AREA PLAN.

A co-ordinated plan of security in depth is necessary—depth much greater than that which has heretofore been considered adequate. Present doctrine regarding the use of barriers for what may be considered "exterior security" is generally sound, but a complete barrier plan must anticipate the possibility of the penetration of such barriers and make provisions to localize such threats. The speed and distance with which large armoured forces are now able to strike has made the complete dependence upon mobile reserves and counter-attack extremely hazardous. Even the most highly mobile reserve requires an appreciable length of time to deliver a counter-attack, and unless the armoured forces can be slowed down and pocketed, it may be too late.

The best means by which to accomplish the necessary delay is the barrier and, accordingly, the barrier plan must be continuous throughout rear areas. A comprehensive system of prepared demolitions based upon natural terrain lines and ready for instant execution will be the basis for this portion of the barrier plan. Supplementary barriers of mine fields and improvised road blocks, however, will usually be necessary to make the system effective in pocketing a penetration.

Rear area barriers must accomplish an additional end. The first objective of an enemy making a penetration will be the so-called "nerve centres." Such installations as command posts, communication centres, and other vital establishments will have to be carefully located within the barrier network to avoid tank attack. Dispersion of facilities with duplicate or alternate positions for the "nerve system" may be mandatory.

THE ZONE OF CONTACT.

The zone occupied by the forward and flank units of the main force is herein referred to as the zone of contact. Protection must be afforded to troops in this zone; for this purpose, their own anti-tank weapons, supplemented by such obstacles as organic pioneer or engineer troops can construct, are well suited. This procedure is common practice and is only mentioned to emphasize the fact that the means now available to front-line units for barrier operations are vital to those units and cannot be diverted without grave risk by higher authority. One point which may be considered somewhat new is the selection of positions in defensive operations. It now appears that natural obstacles will in many cases dictate such a selection, even at the expense of such considerations as fields of fire, concealment, et cetera.

An outlying zone of destruction designed to delay the enemy by denying to him the use of the road and railroad net and forcing the canalization of his attack may be useful on one or more sectors. The

use of trap mines and chemical agents will increase the effectiveness of the zone and make its passage still more difficult. Radio interference, to harass the control so difficult and vital in operations of armoured forces, is a distinct possibility. The principle that an undefended obstacle is not so effective as a defended one should not be overlooked, however, even in an outlying zone, and opportunities for guerilla tactics on isolated vehicles or parties will occur in this phase; in fact, counter-reconnaissance measures will frequently demand such action.

A few observations regarding obstacles and barriers should be recollected. A continuous combination of natural and artificial obstacles built according to a comprehensive plan constitutes a barrier. Single lines or limited depths must be avoided; the cellular pattern or network based on the terrain features must encompass the entire theatre. Natural features must be utilized. But even in the case of natural obstacles, construction or demolition will be necessary to make them continuous or to supplement weak portions, and much work will thus be required. The effectiveness of an obstacle depends, first, upon its garrison of men and weapons, second, upon its location, and lastly, upon its type. If a garrison of men and weapons is not provided, the effectiveness of the obstacle or barrier in impeding the enemy will be very limited. Little reliance can be placed upon an undefended obstacle; in fact, extensive construction of obstacles or barriers will rarely be justified if active defenders are not also provided. Obstruction of the road net to enemy movement is first in importance. However, if natural defiles do not exist or operations are being undertaken over level open country, such a mission is practically impossible of fulfilment. No readily portable obstacle exists which is capable of delaying tanks with the exception of anti-tank mines. It is not the headlong dash at 60 miles per hour that occurs but the relentless pressure of 25 or 35 or 45 miles per day. Such power cannot be faced without power in the defence. Armoured forces fear the anti-tank gun and the anti-tank mine more than any other artificial obstacles.

Barrier Systems.

Individual obstacles have been classified as to location and time required for placement. Barrier systems may be similarly classified as to location, that is, distant, outlying, close-in, and rear area. However, the mobility of modern mechanized vehicles makes this distinction of limited value, and the necessity for modernizing all security measures to cope with armoured forces must be realized whenever their use is possible. As to the time required for placement, a barrier system cannot be considered quick or even semi-quick, with the possible exception of the mass use of anti-tank mines. A barrier system developed by all other means will be deliberate, no matter

how favourable the natural features may be. Without the knowledge of the theatre of operations and the expected enemy and his capabilities, there is as yet no place in our military plans for extensive deliberate barrier systems. In a moving situation, the modern armoured force does not consider serious a detour of 50 miles for a barrier system, yet the construction of such a complete barrier on average terrain with the necessary obstacles in depth would require a large force working for several days.

The effectiveness of the physical portion of a barrier system (neglecting for a moment the garrison and natural features) depends on the time available for its construction. Therefore, the classification of individual obstacles in order of their effectiveness is important.

For general use :

1. Anti-tank mine field.
2. Abatis.
3. Craters.
4. Log obstacles.
   a. Wall.
   b. Ramp.
5. Improvisations.

For fixed fortifications :

1. Posts and railroad rails.
2. Steel and concrete shapes.

For warning missions :

Wire rolls.

For obstacle protection :

Personnel, mines, and chemical agents.

In considering the physical elements of barrier systems, stream lines should not be omitted, as they form the most effective elements. Nor should watercourses be expected to be of major proportions ; improving the banks of small creeks or enlarging ditches may pay big dividends. Construction or the passage of any barrier zone becomes a special operation similar to operations at a river line, and the necessity for basing modern operations on the most tank-proof natural features will increase the frequency with which river lines will enter the tactical picture.

Before passing on, let us emphasize that it is the *garrison* of an obstacle or of an entire barrier system which will determine the delaying effect imposed upon the enemy. Undefended obstacles will cause very limited delay ; garrisons with small arms will cause the additional delay required for their dispersion before the obstacle can be removed or passed. To prevent the attacker with armoured vehicles from having freedom of manœuvre, the garrison will generally require anti-tank guns. It appears axiomatic that if the obstacles of a barrier system are designed against tanks their garrisons must be armed likewise.

Employment of Armoured Forces.

While present doctrine regarding the employment of armoured forces favours their use in mass on relatively narrow fronts, it must be realized that the mobility and the number of modern armoured divisions in the hands of an active enemy will permit their use for reconnaissance on wide fronts and to accompany infantry-artillery attacks as well. For this reason, the anti-mechanized security must expect all types of attack. All forward and flank units must have their own close protection in addition to those measures which protect the rear areas and the command as a whole. Dependence upon supply and communications did not appear to hold up armoured forces seriously in the Battle of Flanders. However, to what extent this was due to air superiority, limited geographical distances, or superior logistics and material can only be estimated at this time.

Special Situations.

Apart from continental operations or operations of the field army, barrier tactics will be applied in defence of island bases or fixed installations of the zone of interior similarly to the all-round defence of important points in the theatre of operations. Protection against air-borne troops and light tanks should be a part of the defence plan. In the problem of an island base, beach defence is paramount, but barrier organization to contain enemy footholds will be necessary. It is felt that heavy permanent barriers are not justified for two reasons: 1. a permanent obstacle will not be more effective than a mine field; 2. erection of permanent barrier lines presents the enemy with additional information on the defence plan. The planning of the defence, which is to include barrier organization as a part of it, must be done early; in this country plans may be kept reasonably secret, structures, not. The mine field can be placed quickly and cheaply; it is easily concealed; it can be picked up, moved or augmented; and a large element of surprise is retained in the hands of the defending force. Semi-portable or semi-permanent obstacles to deny landing areas or roads to enemy planes may be justified.

Barrier Troops.

As the value of a barrier without a garrison is small, a discussion of troop units is in order. It is the demolition executed after it is too late to change the plan of attack that creates the greatest delay; it is the gun covering an obstacle and preventing its free removal that holds up the advance. The gun or garrison and obstruction are supplementary; each alone is practically helpless against tank tactics. Obstacles, be they ditches, watercourses, walls, mine fields or something else, represent considerable expenditure of effort to be absorbed into the defence plan. We will seek for and utilize "tank defiles" but they will not be found in the depth or frontage required wherever the enemy chooses to employ his armoured force.

The responsibility of engineer troops on barrier and obstacle

missions is rapidly increasing. On Army manœuvres such missions have frequently been paramount for division and corps combat engineers. Close co-operation is necessary between engineer parties which construct obstacles and infantry units which would defend them. Field exercises have rarely progressed to this "take-over" stage and the delay and disorganization incident might be serious at a critical time. In division units, field problems and combat team training will develop the desired teamwork, it is hoped, but corps organizations will have less frequent opportunities for combined training.

No foreign army has organized special barrier troops, but as the trend in tanks and armoured forces is towards larger sizes, so, too, the importance of obstacles and barriers must steadily grow. The composition of a barrier unit could follow no fixed rule, German accounts once emphasized; weapons assigned must suit the situation. Experiments in barrier tactics were reported in the German Army in 1937-1938, with motorized machine-gun units forming the base of the barrier unit and engineer troops a vital component if the terrain failed to provide obstacles of sufficient number or character. Anti-tank mine practice was stressed and anti-tank guns were frequently attached. On occasion, field artillery or anti-aircraft artillery were included, the latter primarily for air targets. The particular importance of signal communications for use within the unit was recognized. Missions assigned such barrier units were always defensive in character even though the main force was acting aggressively. In other words, the barrier unit is a security detachment similar to advance or flank guard. However, security against armoured forces requires the splitting up of the unit into smaller groups; advantage would be gained if organization might start with these groups as cohesive teams. As the necessity for security forces will be present in either offensive or defensive missions, it is felt that troops equipped with engineer tools and armed with anti-tank weapons might be organized into a barrier unit. Such a unit would have as a basis a squad of twelve men with a 1½ ton truck carrying tools, anti-tank mines and explosives, and a light machine gun with anti-air mount, towing a 37-mm. gun and accompanied by a motor-cycle. This squad would be self-contained and could easily be organized into platoons, companies, and battalions.

The writer next discusses operations against barriers. In these the co-operation of all arms, including the air service, will be essential, and the employment of engineers will be vital.

There are some lessons to be learnt from the recent campaigns in Europe. In Poland the nation had no true conception of the use of barriers, nor had the Polish army time to employ them. Norway had no plans to meet a mechanized attack and was completely taken by surprise. On the other hand, the campaign against the Low

Countries is a good example of barrier tactics, both offensive and defensive. The Dutch plan of defence was well conceived and carried out, and, but for the seizure of the bridges near Rotterdam by air troops, the defence might have held out for some time. In the battles of Flanders and of France, such plans as the French may have made were not comprehensive in scope and collapsed owing to the speed of the German advance.

Conclusions.

1. Barrier tactics involve essentially the use of obstacles and weapons in combination to provide security against hostile forces.

2. At present no one branch of the service is organized, trained or equipped to execute barrier missions. Barrier tactics require intensive combined training.

3. No single barrier can be considered invulnerable to penetration by an enemy possessing large armoured forces. A system of barriers, embracing the entire theatre of operations must be designed and prepared to combat such penetration.

4. Permanent barriers of heavy obstacles, either prefabricated or fabricated in place, have no place in any probable operation of a field army. Their use will be limited to deliberate positions for defence of fixed objectives and, even then, local improvisations and materials will generally suffice.

5. Any fabricated or improvised obstacle which depends on physical bulk or structural strength for its effect is only a substitute for an anti-tank mine field.

6. To obtain maximum effect from any obstacle, the fire power protecting it must be such that neutralization of this fire must be the first step in passage.

7. Artificial obstacles not supported by fire effective against vehicles which they are designed to stop can only be counted upon to cause momentary delay.

8. The small numbers of anti-tank weapons now contemplated by *Tables of Organization*, the practical difficulties involved in securing these weapons for use in barrier operations, and the need for close co-operation between troops placing obstacles and troops which have weapons to garrison them, shows the need for forming special barrier units to be available to higher headquarters.

9. Maximum use of natural barriers is imperative, even at some sacrifice of elements such as concealment, field of fire, etc.

10. The use of anti-tank mines will reach proportions not heretofore contemplated and supply of these should be considered comparable to that of other types of ammunition, both in importance and volume.

11. The practice of reserving authority for execution of demolitions to high commanders is unsound. The senior man present on the site is best qualified to judge the local situation and determine whether or not a demolition should be executed.

THE TRAINING OF THE JUNIOR N.C.O.

By LIEUT. P. DRAKE-WILKES, R.E.

THERE is an old saying about endeavouring to instruct one's Grandmother in the art of dealing with eggs. It is therefore with a certain amount of trepidation that I commence this article and with the saving clause that it is written by a subaltern for subalterns. A Section Officer in a Field Company has one of the finest junior commands in the British Army and one with a tremendous scope for the exercise of his own initiative. He is required to disarm a minefield or build a hospital, blow up a bridge or construct a road, with equal impartiality and whatever kind of job he makes of it depends to a great extent on the worth and knowledge of his N.C.Os.

A Sapper N.C.O. has got to be a Jack-of-all-Trades and a master of each and it is the responsibility of the Section Officer to train him. That is the crux of the whole matter—the responsibility of the Section Officer. On him depends their efficiency and only by constant endeavour and hammering, can he attain that dream of perfection ; that of giving an order and knowing that it will be properly carried out without unnecessary questions and in the minimum of time.

To reach this ideal means hard work and an organized programme. At the same time it must be borne in mind that most of the training will have to be done in the evenings and after duty, so the programme must be flexible and capable of being split up into short periods of say half an hour.

The N.C.Os must also be made to do a certain amount of study on their own account and to stimulate this I have found it is a good scheme to have a short *questionnaire* duplicated and given out. This is a specimen one ; the wording at the top is designed to allow for a certain amount of face-saving :—

DUTIES OF JUNIOR N.C.OS.

As an N.C.O. you are expected to know far more than a Sapper. You do, but there are many things which you should know which probably you haven't been taught, or haven't bothered about. Have a look at the list below and being quite honest with yourself, see if you can answer all the questions. If you can't, look up the answers, worry me, or the C.S.M., and find out.

General.

1. Have you got a gospel (a notebook with everything in it, which you can turn up in an instant) ?
2. In your gospel you should have—
   List of G. 1098 tools carried by a section of a Field Coy.
   Demolition Formulæ.
   Reconnaissance report layouts.
   Etc., Etc., Etc., Etc.,
   Do you know all this ?
3. Can you orient a map ? Could you take a sub-section across country from map reference to map reference by day or by night ?
4. Can you read a compass ? Do you know all the ways of finding the north or south without one ?
5. If you met a Mk. I, II, III, or IV A/T mine could you compete ? Have you ever seen a beach mine ? How would you deal with an unexploded bomb or an unexploded 3" Mortar ?
6. Do you know what is on a 3-ton explosive lorry ?
7. Do you realize that even 3 detonators cannot be relied on to initiate F.I.D. ? What is the thickest diameter of a G.C. primer ? Do you know there are two types in use nowadays.
8. Do you know how to patch bullet holes in
   (*a*) F.B.E's (*b*) Pontoons.
9. Do you know about Booby Traps.
10. Can you operate the R/T side of a wireless set ?
11. Do you know the best layout of a firing party ?
12. How would you put a Bosche Tank out of action ? It's fairly easy ; do you know the way ?
13. Can you write a message.

M.T.

You are in charge of a sub-section and have a 30 cwt. truck to transport your men and tools.

1. Can you drive ? If you can't ; do you know which is the brake and how to put it on.
2. Can you work a winch on a Winch lorry ? (There is one Winch lorry per section, it may be your sub-section lorry.)
3. Do you know about a compressor ?
4. How many miles per gallon does a 30 cwt. lorry do ? How many gallons can be put into the petrol tank ?
5. Take an interest in your vehicle, see that the driver maintains it properly. In present warfare your own and your men's lives may depend on it.
6. Do you know the name of every man in your sub-section ? You should in a week.
7. Do you see if a complaint is put through the proper channels

and something done about it? It is your job as much as the Serjeant's and the Officer's.

8. Can you take over the next man's job at once?
9. Are you cleaner and smarter than any of the men below you?
10. *Gas*: Do you know enough about this? If you do make sure your men know it; an odd question now and then helps.
11. Do you know the recent and less recent history of the Corps? Do your men know it? Do they realize what reputation they have to keep up? Do you know the history of this Company?
12. Are all Jack knives sharp? They must be.
They are vital tools for demolitions.

Etc., Etc., Etc.

As can be seen, it isn't by any means complete and it rests with the individual section officer to put in questions on which he knows his N.C.Os are weak.

Having got as far as this, arrange a programme of talks or lectures on the lines of your own *questionnaire*. Give the first talk yourself, explaining the object of it all, and finishing with a brief outline of the many things a Field Company is called upon to do.

After that, detail an N.C.O. to prepare the next talk, or better still, tell everybody to prepare a lecture on the subject set, then pick on someone the next time to give it. Let the others criticize and make suggestions. Always make a point, however, of closing the discussion yourself, make a summing up of it, point out any mistakes and give the proper answers, or your own ideas on the matter.

Try to get outside experts to come along for an evening; new faces are always welcome—but for heaven's sake, don't let them talk for longer than forty minutes! N.C.Os are just as human as anyone else and half to three-quarters of an hour is just as long as the ordinary person is prepared to listen.

Encourage new ideas. You'll be surprised how much you yourself can learn and the little tricks of every trade can be found very useful in a Sapper unit.

I remember at one session we had, someone got up to give the usual criticism—the subject of the evening was mining—and after a few of the customary remarks, proceeded to give a really excellent talk on quarrying. This had been his job before the war and one or two of the tips he gave us we incorporated in the job of work the section was then doing, which was digging ammunition dumps in rocky ground.

Well, there you are! If you haven't done anything like it up to date, have a shot at it and when you've finished your course you'll almost certainly be able to say "My section is the best in the Company" with far more justification than you've had before.

RAILWAYS AND HARBOURS IN TROPICAL AFRICA.

A Brief Record of the Work of the Royal Engineers in Recent Years.

The Corps has been associated with Railways in tropical Africa from early days (as is instanced by the inception of the Uganda Railway) and the connection with these Railways has been kept up by officers employed on surveys, reports, management and in other departmental offices, in some cases even up to the present day.

The work of this nature undertaken by the Corps in Egypt and the Sudan has been described in Lieut.-Colonel Sandes' book *The Royal Engineers in Egypt and the Sudan*. Here we are dealing only with tropical Africa.

Northern Nigeria.

Baro-Kano Railway.

1908—1911.

In the Memoir of Sir Percy Girouard, published in *The R.E. Journal* of June, 1933, the reader will find an account of how it was decided to build a 3' 6" gauge railway from Baro, some 400 miles up the River Niger, to Kano—a distance of 349 miles, exclusive of a branch of 36 miles to Zungeru, the then capital of Northern Nigeria. Sir Percy arranged with the War Office for a detachment of R.E., consisting of 3 officers (Captain Mance, in command, Lieutenants F. D. Hammond and G. A. P. Maxwell) and 30 other ranks from the R.E. troops at Longmoor, to be lent for this purpose for 3 tours of service. All the Other Ranks were given the temporary rank of Serjeant to give them the requisite status *vis-à-vis* their civilian opposite numbers.

The first duty of the Detachment was to unload machinery, stores, locomotives and rolling stock on the virgin bank of the Niger. In this the Sapper training for improvising lifting tackle was invaluable.

Subsequently the Detachment was entrusted with :—

(*a*) the plate-laying, ballasting and maintenance of the advance section, under Lieut. Maxwell ;

(*b*) locomotive erection, maintenance and operating under Lieut. Hammond ;

(*c*) traffic and commercial development under a civilian Assistant Traffic Manager.

The delivery of material at railhead with very limited rolling stock over newly-laid track threw a great strain on the locomotive staff. The Detachment established a world's record for telescopic track-laying, having laid from construction trains during daylight in one day $6\frac{1}{3}$ miles of main line besides 2 sidings, each 200 yards long, failing light preventing the linking up of the balance of 7 miles of track actually laid out by the carrying gangs.

140 miles, plus 5 miles of sidings, between Kaduna and Kano, were laid between December 12th and April 1st. As there was no Sunday working this meant 94 working days, an average of $1\frac{1}{2}$ miles of main line per working day. The temperature was rarely less than 105° at midday and at times up to 109°. The biggest month was March, 1911, when $42\frac{1}{2}$ miles of main line and 1 mile of sidings were laid in 27 working days. The best week (6 days) was $12\frac{1}{4}$ miles plus shifting camp.

The commercial development of the line *pari passu* with construction of the railway brought in considerable Revenue during the last year of construction and developed traffic which reached the full capacity of the rolling stock available soon after the completion of the railway.

The detachment returned towards the end of 1911, having lost only one man. Some of the Other Ranks were retained in permanent civil jobs on the completed railway.

The results of the Baro-Kano Railway was the opening up of the whole territory of Northern Nigeria to commercial undertakings and the cessation of military expeditions of a punitive nature.

1914—1919.

Wartime saw the cessation of the employment of R.E. officers in a civil capacity, but it must not be forgotten that the re-construction of the damaged railways in German East Africa and the construction of the Voi-Taveta Line in the British East African Protectorate were largely the work of the Corps.

POST-WAR.

On the cessation of hostilities, various important positions in the tropical African Railway world became vacant and within a short time the Corps had its representatives as General Manager, Rhodesian Railways, General Manager, Tanganyika Railways, Chief Engineer, Uganda Railway, and it is of interest to note that in 1923, in addition to the above mentioned posts, the General Manager, Traffic Manager and Chief Engineer of the Sudan Railways, the General Manager of the Egyptian State Railways and the General

Manager of the Egyptian Delta Railways were all regular Sapper officers.

Rhodesia.

In Rhodesia, Colonel C. F. Birney, occupied the important position of General Manager, Rhodesian Railways from 1919 to 1929.

The Rhodesian Railway system, 2,541 miles in length, comprises seven companies, each a separate financial entity, but operated as one concern.

The $10\frac{1}{2}$ years fall readily into two periods: the first about three years, during which the main problem was recovery from the effects of the war—a period of rapidly rising prices, shortage of material and unsettled labour conditions. The second period, of about 7 years, presented a different problem—that of keeping pace with rapid expansion and growth of traffics, principally due to developments in basemetal mining in Southern Rhodesia, the Congo and Northern Rhodesia.

The following figures, comparing results in 1919 and 1929, will indicate the extent of these increases:—

Gross earnings rose from £1,795,000 to £5,428,000.

Train mileage rose from about 2,500,000 to 6,206,000.

Ton mileage rose from 458,000,000 in 1921 to 1,104,000,000 in 1929. (This does not include the Vryburg-Bulawayo section).

Extensive programmes of improvement were undertaken during the period to convert what was essentially a Colonial pioneer Railway into an efficient instrument carrying heavy traffic. During this period over 10 million pounds were spent on capital works. Train loads were increased by the elimination of curves and gradients; the main line was stone ballasted, more and heavier sleepers were put in the track and bridges were strengthened to take 20-ton axle loads.

At the same time public interest became more focussed on the Railways and, as a result of two Commissions, legislation was introduced by the three Governments concerned to control and limit the profits which the Railways could earn for their shareholders and to ensure that increasing prosperity on the Railways should be reflected in rates, roads and fares. It is estimated that during the 10-year period, reductions of rates were granted involving an accruing surrender of revenue of something over £1,500,000.

Colonel Birney left the Rhodesian Railways just before the sudden slump which overtook the world, including Africa, in 1930.

Tanganyika.

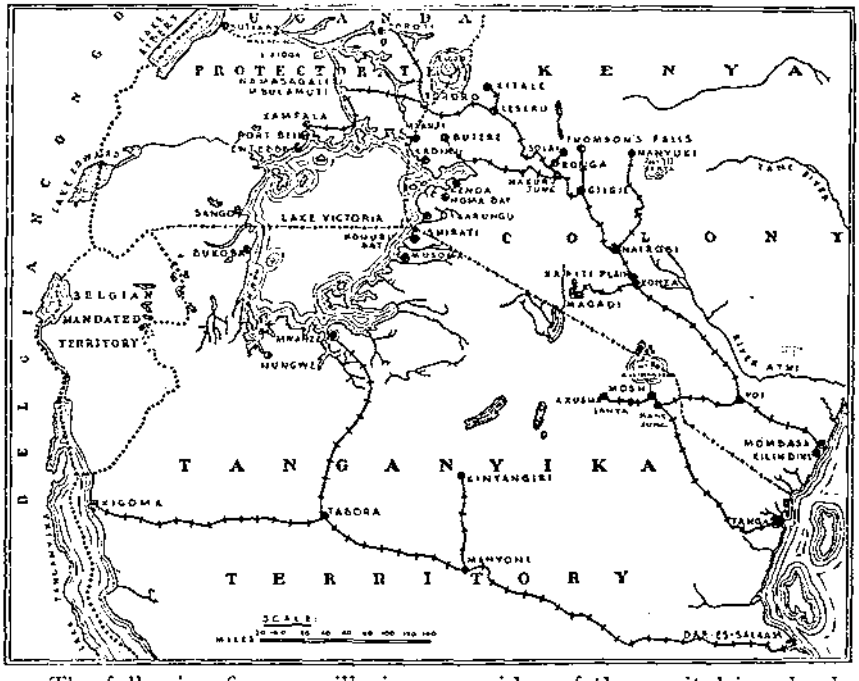
The Tanganyika Railways were in the hands of Colonel G. A. P. Maxwell from 1920 to 1935.

When the Civil administration took over control from the military

authorities in April, 1919, very little was done to staff the Railway on modern lines, or to make good the ravages of war in equipment and dislocation.

Accounts were very behindhand and no proper budget existed during the ensuing eighteen months.

The work of re-construction of a railway in a poor physical condition, and of which the commercial value was practically nil, took some years, owing to the small amount of money that could be made available for the purpose. At the end of 1923, however, it was possible to begin re-construction and consider new construction. Loans for this work were obtained from the Home Government.



The following figures will give some idea of the capital involved and of how it was spent :—

Early re-construction Track and Power	£398,700
Additions and Improvements to 31/12/35	
Railways	2,339,363
Lake Steamer Service	72,225
Marine	66,574
Dockyard	15,664
Wharves	314,054
	2,807,880

Capital Expenditure to 31/12/35.

New Construction.

Tabora—Mwanza Railway	893,518
Manyoni—Kinyangiri	539,896
Moshi—Arushi	316,019
Engare Nairobi Branch	29,133
Sanya Branch	26,327
	£1,804,893
	£5,011,473

Revenue Account, Railways.

	1920/21.	1930/31.	1935.
Receipts	£157,393	£805,712	£594,159
Expenditure	346,300	572,668	317,994

Revenue Account (All Services).

Receipts	£157,393	£937,542	£662,269
Expenditure	346,300	679,099	350,893

The Railway was largely used as a means of developing the territory and has not actually paid its way up to date.

The system consisted originally of two lines:

Dar es Salaam to Kigoma	780 miles.
Tanga to Moshi	220 miles.

to which were added :—

Tabora to Mwanza	235 miles.
Moshi to Arusha	54 miles.
Manyoni to Kinyangiri	93 miles.

Lake and Marine.

In addition to the Railways, the Ports and Harbours, Coastal Lighting and buoyage were included in the work of the General Manager and a service of 2 ships on Lake Tanganyika was inaugurated after sundry surveys had been made and navigation marks and lights installed. This Lake Service opened up the Abercorn area of Northern Rhodesia to settlement and trade.

Kenya and Uganda.

Brigadier-General Sir Godfrey Rhodes, arrived in East Africa at the end of December, 1920, to take over the post of Chief Engineer of

the Uganda Railway (as it was then called), on demobilization from the British Forces of Occupation in Constantinople. As he belonged to the Indian Establishment, he should normally have returned to India, but was seconded to East Africa for two tours of 3 years each.

The Uganda Railway at that time consisted of 685 miles of single line, including a branch between Jinja and Namasagali and another between Port Bell and Kampala. There was a Marine Service on Lake Victoria and on Lake Kioga and the above two small branches served to connect the two Lakes in the first case and the port with the capital of Uganda—Kampala—in the second place. To give an idea of the size of the Railway at that time, it may be stated that the capital expended on the railway at the end of March, 1921, amounted to £7,318,784, the revenue earned was £1,175,441, while the train miles amounted to 1,559,287.

The Railway had suffered considerably during the war from lack of maintenance and from the fact that the Government of Kenya, which was running it at the time, had to depend to some extent upon the revenue of the Railway for the financing of the Colony's Administration. From 1923, onwards, however, there were signs of great development throughout the whole of East Africa, including Uganda, where the cotton crop began to assume larger proportions. Money for new construction became available and by the end of December, 1928, the capital had increased to £18,902,385, representing an expenditure of £10,611,972 in approximately five years. Not only were there considerable extensions of the Railway, but a very efficient and modern port was built at Kilindini and opened in 1926. In addition, the Marine Services on Lake Albert were taken over and incorporated in the services.

Sir Godfrey Rhodes became General Manager in 1928 and is still in charge.

Since 1928, the position has been consolidated with some additional growth in the length of the system and, of course, a very heavy increase in the traffic handled. At the end of December, 1927, the Capital Account stood at £22,151,873, while the revenue earned was no less than £3,228,765. The mileage of open line had increased to 1,622 miles, while 3,817 miles of Marine services were also operated, together with an efficient Road Service between Masindi Port and Butiaba, 75 miles in length, dealing with 1,655,810 tons per annum.

With the extension into Uganda, the former "Uganda Railway" became known as the "Kenya and Uganda Railway" in 1925, while in 1927, this was extended to the "Kenya and Uganda Railways and Harbours." Its finances are now completely separate from those of Government and its affairs are administered through an Advisory Council and a High Commissioner for Transport (the Governor of Kenya) who, with his opposite number, the Governor of Uganda, are the Joint High Commissioners for Transport.

BRIGADIER-GENERAL F. D. HAMMOND.

Kenya. Late in 1920, the Secretary of State for the Colonies, nominated Brigadier-General F. D. Hammond to report upon the administration, management and finance of the Uganda Railway. A report of this nature entails, if it is to be done conscientiously, an enquiry into every phase of the working of a railway from the operations of its trains and steamers to its methods of accounting, to examination of the routes which future extensions should take, and to the pay and privileges of the staff. This had to be done single-handed.

Tanganyika. Later, a similar enquiry into the Tanganyika system was added to the task.

Reports, submitted in the autumn of 1921 included a complete tariff of rates and a goods classification, on an up-to-date basis.

Gold Coast, Sierra Leone, Nigeria. In 1922 to 1924 similar reports were made on the railways of the Gold Coast, Sierra Leone, and Nigeria.

Rhodesia. After retiring in January, 1925, he was commissioned by the Southern Rhodesian Government to enquire into the administration, changes and finance of the Rhodesian system. Five different Companies were concerned, running through five different countries, each Company having its separate finances, though sometimes interlocked with that of its neighbours and in all cases under agreement with them, and it had to be decided how the capital had been raised and spent and whether it had been watered.

Nyasaland. In another report on the transport situation, possibilities and requirements of Nyasaland, he was assisted by the late Major E. O. A. Newcombe.

As a result of the report, negotiations were opened with the Companies who owned the railways. They were concluded successfully by an agreement signed in October, 1930, between the Nyasaland Government and the Railway Companies. By this agreement, a new Company—Nyasaland Railways—was formed and Government capital was advanced to it in order to enable it to extend the railway to Lake Nyasa and to build a bridge over the Lower Zambesi. The latter, completed in 1935, is the longest bridge in the world, being $2\frac{1}{4}$ miles in length. Brigadier-General Hammond was appointed Government Director on the Boards of Nyasaland Railways and the Central Africa and Trans-Zambesia Railway Companies.

He was elected in 1929 to the Boards of Rhodesia Railways and the Mashonaland Railway Company by the Directors of those Companies; and later elected a Director of the Beira Railway Company as well.

RAILWAY SURVEY IN NIGERIA.

NIGERIA.

In April, 1928, Lieutenants J. F. Leese and R. E. Bagnall Wild proceeded to Nigeria as Assistant Engineers for Railway Survey and were attached to the Survey Department of the Nigerian Railway.

Leese was first employed on the relaying of the Ibadan-Offa section for seven months, re-aligning curves, etc., in front of the relaying party. He was then employed for six months on the Odo-Oba-Akure route selection Survey, a proposed branch line through very thick and broken bush country in the Cocoa Area. For the last five months of his eighteen months' tour he was at the Survey Headquarters at Kaduna preparing plans and sections of the Odo-Oba-Akure Survey and also on Survey for the re-grading and re-alignment of portions of the Zungeru-Kaduna section of the existing Lagos-Kaduna line.

Bagnall Wild started on the Odo-Oba-Akure Survey and after about 4 months there joined the Lafia-Chad route selection Survey, a proposed line branching off from Lafia, on the Eastern Railway (Port Harcourt-Kaduna). This survey was an extremely interesting one, as it traversed undeveloped and sparsely populated country, and entailed the crossings of a number of rivers, the Gongola, a tributary of the Benue, being the largest. An account of the survey was written by him for *The R.E. Journal* of December, 1936.

These two officers would have continued for a second tour on survey had not the world slump set in and all surveys, construction, etc., been abandoned.

TANGANYIKA.

Between 1930 and 1932, three officers—Captain D. M. J. Murray, Lieutenants C. G. B. Greaves and C. E. M. Herbert—were afforded valuable experience in railway survey when they were appointed as Assistant Engineers under the Tanganyika Railways.

These officers were employed in one party and were principally occupied in the preliminary survey (tacheometric) and estimates for an intended feeder line running south from the Central line at Kilosa. The alignment of this proposed branch followed roughly the foot of the first great escarpment, 200 miles inland and parallel to the coast, and the southern terminus was located near the Kilombero River, a distance of over 100 miles.

Although the immediate aim was to encourage native development of this very fertile valley (by connecting the railway to the navigable portion of the river) the branch possessed an added interest in that it might one day constitute a portion of a railway connecting East Africa with the South *via* Northern Rhodesia.

Owing to the financial crisis—the survey and any thought of construction had to be abandoned and the party, which had done valuable work, had to be dispensed with by the Tanganyika Government.

Gold Coast.

The fine port of Takoradi in the Gold Coast undoubtedly owed its inception to Brigadier-General Sir Gordon Guggisberg.

This port was commenced in October, 1923, and opened on 3rd April, 1928.

It has proved of enormous advantage to the trade of the Gold Coast, which territory, prior to the opening of Takoradi, was served only by surf boats on various open beaches.

Report on Transport Co-ordination in East Africa.

In the autumn of 1936, at the request of the Colonial Office, Brigadier-General Sir Osborne Mance, who had specialized in the road and rail question for some years, reported on the co-ordination of transport—rail, road, waterways and air—in Kenya, Uganda and Tanganyika, his Report being issued by the Crown Agents in December of the same year.

The Report was of great value to the Governments concerned and has been largely used in the framing of the new Transport Bills which have been recently introduced and passed by the various Legislative bodies.

AUSTRALIA'S WAR EFFORT.

Extracts from the Presidential Address delivered by Lieutenant-Colonel G. Drake-Brockman, M.C., M.I.E.AUST., to the Twenty-First Annual General Meeting of The Institution of Engineers, Australia.

(From *The Journal of the Institution of Engineers, Australia*—April, 1941.)

AFTER calling attention to the military weakness of Australia's sparsely inhabited northern areas and recommending the acceptance of a scheme for the settlement there of refugees from Europe, and the storage of water in these areas as a protection against the effects of the long droughts, the President continued :—

" For eighteen months Australia has been at war. During that period we, as engineers, both individually, and collectively as an Institution, have made considerable contribution to the national effort. Observation leads me to believe that materially we have done everything that has been asked of us. But observation leads me also to believe that, one might say morally, there is much more we can do ; and, at the same time, much more we should be asked to do, materially, by the leaders of the Commonwealth. *A body of opinion such as our Council offers, were that opinion sought and utilised, must surely prove of immense value at the present time.*

Immediately the international situation became a direct menace, The Institution arranged through its Divisions for a registration of all members. This information has proved of some use, both for military and industrial purposes ; nevertheless its application has fallen short of what we hoped.

Up to the present time The Institution has supplied approximately two hundred officers for the fighting forces going abroad, and some hundreds for Militia and Home Defence, which include necessary requirements for the Engineer Services for Navy, Army, and Air Force, and the Command Staffs throughout Australia.

As you know, the *National Security Manpower Regulations* prohibit the general enlistment of engineers. Their services must be required for the Forces in a technical capacity, before any can be released for service either at home or abroad. It is, moreover, necessary to limit the Defence Forces to bare technical necessities, because of the vital needs of ordinary essential services, such as water supply, sewerage, lighting, lines of communication, etc. The adequate staffing of such services is possibly, at this moment, even more necessary than the staffing of Home Defence, because the maintenance and smooth running of such essential services might be called the starting point of all national war effort.

In addition to these various service needs, enormous demands

have been made on our members by the construction of new factories for the manufacture of war equipment, and also for supplying such home requirements as were formerly imported. Following the completion of new factories, comes an ever-increasing demand for engineers to engage in every form of war industry. Never before in the history of Australia have the members of our Institution been so sought after. Already, the demand for technical experts in every grade of our profession, can indeed only be met with difficulty. Meantime, industrial expansion continues on an unprecedented scale, and will continue to absorb more and more Chartered Engineers. We could, I think, ask ourselves whether, as an Institution, we are doing enough to speed up training of technicians so that the increasing demand may adequately be met.

Small arms, ammunition, 'planes, war equipment of all kinds are now being manufactured in Australia to an extent which would have seemed fantastic twelve months ago. Before the war, Australia manufactured but a small percentage of her total civilian requirements—there were hundreds of imported articles which we had no means of making, even had we so desired. As for lethal weapons—with the exception of rifles and rifle ammunition and possibly some few similar lines—such things were beyond our horizon. To an extent, aeroplane building had commenced, but generally speaking, and for all practical purposes, our navy, our land forces, our air forces, were all armed and even mainly equipped from overseas.

The position to-day is startlingly, magnificently, different. What manufacturing industries we had, both light and heavy, have been swung over from peace-time production to the making of guns, shells, the thousand various necessities of war. New factories have arisen. And, because we were unable to import even the necessary machine tools, we have made those tools. *Probably the machine tool industry in this country as it stands to-day, can justly be regarded as Australia's greatest feat in her war effort to date.* To take just one example, a firm which did not even exist twelve months ago, is to-day copying 24 German cartridge machines. Possibly only a section of our own members, even, realize how much has been achieved, whilst the general public appears to be entirely unaware. It is almost unbelievable that Australia should already be sending overseas vast quantities of war materials, in addition to equipping and keeping supplied the Navy, A.I.F., Air Force, and Home Service units. Dozens of technical schools throughout the Commonwealth are working two shifts a day in order to train the skilled men required for the proper usage of precision tools, and factory work generally.

Towards the end of last year, the Department of Information issued a pamphlet on *Australia's War Effort*. This contains a number of interesting facts and some useful figures, and could with advantage be more freely circulated. Perhaps a few figures are worth quoting now.

For instance, War expenditure from 1938 until 1942-43 is estimated to cost £453,000,000, as set against the total cost of £270,000,000 approximately for the last war. Moreover, for the first 10 months of the present war, enlistments for overseas totalled 121,230 as against 26,845 for the first 10 months of the 1914-1918 campaign.

The Government's policy to provide a land force of 250,000 for Home Defence is already well on the way towards completion. By October last, the personnel of the R.A.A.F. was eleven times greater than at the outbreak of war.

By June, 1940, 15,200 persons were engaged on essential work, producing munitions in government factories and munition annexes. This figure had increased to 22,000 by October of the same year. During the last war the highest number ever employed on munitions was 2,737. Now production is protected by a number of reserved occupations; 15,000 men have already been refused permission to enlist on the grounds that they could best serve their country by remaining in industry. By July, 1941, it is estimated that 150,000 people will actually be engaged on the production of munitions and material for munitions.

No less than seven shipyards are already engaged in Naval shipbuilding as against one operating at the outbreak of war. It is expected that 50 patrol vessels will be completed in Australia by the end of the year. Provision for the construction of destroyers and escort vessels is also included in the first £6,000,000 building programme.

The rate of output of rifles was 15 times greater at the end of May, 1940, than in April, 1939, and the rate of output of machine guns was 6 times greater.

Early last year the building of a £300,000 factory for 25-pounder guns was authorized by the Government. It was stated at the end of October last that the factory would be in production shortly.

The number of military aircraft in Australia has been more than doubled, and we are also building our own aeroplanes. Factories have been erected in New South Wales, at a cost of a million pounds, for the manufacture of twin-row Wasp engines for bombers.

Under war conditions, the Government assumed the responsibility of marketing all principal primary products; within five months, contracts were arranged for the sale of £113,000,000 of wheat, wool, meat, etc.

These facts all show that a very considerable effort has been made. But, great as our effort has been, I am convinced it should be—that it *must* be—infinitely greater—if we are to be left free to follow our own way of life and write our own specifications for a future existence unshadowed by that dread New Order now darkening Europe."

R.A.E. IN MIDDLE EAST.

THE President received the following letter from Brigadier C. S. Steele, M.C., B.C.E., M.I.E.AUST., Chief Engineer of the 1st Australian Corps of the A.I.F., Abroad, under date of 19th February, 1941.

" It may interest members to have a few details of the work done by the Royal Australian Engineers in the recent advance from Sollum to Benghazi.

In the original attack on Bardia the 6 Aust. Div., which includes R.A.E. 6 Div., only were engaged, but as lines of communication stretched more engineers were required, so that by the time Benghazi was reached all available Australian engineers in the middle East were actively engaged.

Amongst the engineers, the star role naturally was played by Lt.-Col. Lucas's command, in which I should think eighty per cent. of the officers are members of The Institution.

Their tasks in the attack were to make gaps for the infantry in wire entanglements, using Bangalore torpedoes, to clear lanes in minefields for the passage of tanks and other vehicles and personnel (this involved the disarming of anti-tank mines and booby traps by the thousand) and the preparation of causeways to let the tanks cross anti-tank ditches. The carrying out of this work involved much reconnaissance, preparation and practice in addition to the actual operation itself.

With the eviction of the previous tenants, the restoration of essential services then became the question of the hour and successively at Sollum, Bardia, Tobruk, Dernia, Barca and Benghazi the R.A.E. of various Divisions and also some Pioneers have done sterling work in restoring water supply, electric light, port facilities, and road and railway communications.

The shape of the country is uniform in that there is a low level plain at sea level and a high level plain at anything from half a mile to fifty miles from the coast with a steep drop, called the escarpment, separating the two. There were all told in the advance eight narrow, steep, zigzag roads between the top of the escarpment and the coastal plain. In all cases the Italians had endeavoured by mining, cratering or blowing bridges, to render these impassable. In no case did they seriously delay the advance. In one case when it was thought that the road would be blocked for fourteen days the advance transport was got through in nine hours. Some of it admittedly had to be man-handled, but that was no comfort to the Italians. In this work air compressors, of which there are three with each company, proved invaluable.

Considering the nature of the operations our casualties, I am glad to say, were comparatively light. Whilst the operations became easier after Tobruk, the initial opposition both at Bardia and Tobruk was stubborn up to the time that demoralization set in owing to tanks getting round the flanks. During the initial opposition our men were marvellously lucky in that so few were hit.

Throughout the advance and the subsequent consolidation, the sappers did magnificently, and conditions of modern war appear to assign to them a primary role, although one should never forget that all arms and services exist only to serve the infantry."

MEMOIR.

MAJOR-GENERAL SIR DUDLEY H. RIDOUT, K.B.E., C.B., C.M.G., Officer of the Order of St. John of Jerusalem.

DUDLEY HOWARD RIDOUT was born in India on 15th January, 1866, the eldest son of Lt.-Colonel J. Bramley Ridout, 80th Regiment and 90th Light Infantry—now the South Staffordshire Regiment and the Scottish Rifles (Cameronians). Dudley began his education at Christ's Hospital, but in 1875, his father (then a Captain) was appointed the first Adjutant of the Royal Military College, Kingston, Canada, and moved to Canada with his whole family, when Dudley completed his education, first at the Kingston (Ontario) Collegiate Institute and then at the R.M. College. His father rejoined his regiment on promotion in 1881, and retired in 1886, when he settled at New Brompton, now Gillingham. There he was well-known to many generations of R.E. officers, and was the first Mayor of Gillingham, Kent, when it was made a Borough.

Dudley remained in Canada and completed his course at the College with distinction, taking the first prize in all subjects, save one, receiving the Gold Medal and obtaining diploma honours. He was also selected for the commission in the Royal Engineers which was then given yearly to a cadet from the R.M.C. But in 1885, a large increase of the officers of the R.E. was in progress, and Ridout found himself one of a batch of eleven Canadians (cadets and ex-cadets) which was headed by W. G. Stairs.

His courses at the S.M.E. lasted less than a year and in the spring of 1886, he was one of twelve officers detailed for training in Submarine Mining at Gillingham. On completion of this course he was posted to the 22nd Coy., R.E., at St. Mary's Barracks. The following year he was selected for temporary duty under the Inspector of Submarine Defences at the War Office and was sent to arrange the mining defence at Edinburgh, where a section of the Coast Battalion had just been formed. At the end of 1889 he went abroad to command the Submarine Mining Company at Singapore, with the local rank of Captain; here he remained three years. On returning home in 1893 he joined the 28th (S.M.) Coy., at Gravesend and was promoted Captain on 1st October, 1894.

At the end of this year he took the headquarters of the 28th Company to Malta to change places with the 34th Coy., which he brought back to Gravesend. It was rumoured that the books and accounts of this company had got somewhat involved but Ridout soon got them into order. Shornmead Fort, the headquarters

Maj Gen Sir Dudley H Ridout KCB CB CMG

of the company, is rather isolated but it is close to the rifle ranges and Ridout soon formed a flourishing rifle club which he encouraged to practice, with the result that his company became the best shooting company in the Corps, and kept this position for some years. The team included Sapper Gale, who was a well-known international shot.

In 1897 Ridout was moved to the office of the Inspector-General of Fortifications in Whitehall and was there at the outbreak of the War in South Africa. The R.E. had at that time no organized searchlight units, but on a demand from the seat of war, one was formed and Ridout was given the command. In this unit all vehicles were horse-drawn, the engine and generator being mounted on one wagon and the projector and cable on a second. The technical personnel were drawn from the Submarine Mining companies. This unit was employed in various operations, but when the system of blockhouses and barbed wire developed, the lights became stationary and Ridout was then required to convert his " aquatic " sappers into the 4th Field Troop. Once the men had learnt to stick to their horses, the troop did good work with the Cavalry and Ridout was attached to the Intelligence Department and graded as a Staff Captain.

For his services in the war, Ridout was mentioned in despatches, and received the Queen's Medal with three clasps and the King's Medal with two. At the end of the war he was given the command of the 46th Field Coy., receiving his promotion to Major on 22nd August, 1902. He served with this company at Middelburg, Cape Colony, where he was C.R.E., until he brought the company home to Chatham in 1906.

The following year he was selected for appointment as O.C. Railway Companies at Longmoor Camp. Up to the time of the South African War, the two railway companies of the R.E., the 8th and 10th, had been stationed at Chattenden and Woolwich, neither station including practice with a railway of normal gauge. The experience of South Africa showed that more was required and when the R.E. railway companies were ordered home from S. Africa, in 1906, it was decided to form a new organization at Longmoor, where they could work on a branch line from the South-Western Railway at Bordon and where a training centre and depot could be formed for the railway service. This scheme had been started the previous year, but it fell to Ridout to organize the details, which he did very successfully. In addition to the R.E. companies, two railway companies from the Royal Anglesey and Royal Monmouthshire Militia did an annual training at this school. Ridout vacated this appointment on promotion to Lt.-Colonel on 1st October, 1910, when he became C.R.E., Dublin.

Two years later he was ordered to Singapore as C.R.E. Under

the rules then in force he had three years' service to put in to complete five years in the rank of Lt.-Colonel, at the end of which time he would have had to retire on retired pay unless selected for a Colonel's appointment. As the R.E. Colonel's list was then very congested, his future prospects were not good.

Singapore in 1912, was a much smaller place than at present, the military garrison included R.G.A. and R.E. for the Coast Defences, with a battalion of British Infantry and a battalion of Indian Infantry. The defences were concentrated round the small harbour which contained the one important dockyard. The garrison was commanded by a Major-General, with a small staff.

There was in the Malay States a force called the Malay States Guides, recruited in India and including Infantry and Artillery.

The port itself is one of the natural crossing places of the world's shipping, all the main lines of shipping from Europe to Japan and the Far East and some of the lines to Australia, passing through the Straits. There are also local lines to the Dutch and other islands which form the East Indies

On the outbreak of the Great War in August, 1914, Singapore, like all other coaling stations, was placed in a state of defence. The nearest German fleet was at that time centred at Tsingtau, the defended port of the German settlement of Kiautschau, in North China. But between that place and Singapore, there was a strong British fleet at Hong Kong. This fleet, as soon as it had completed its mobilization, endeavoured to bring the Germans to action, but the latter escaped across the Pacific until destroyed in the battle of the Falkland Islands. They had, however, left one small cruiser, the *Emden*, which for some weeks operated successfully against British shipping in the Indian Ocean, attacking Madras and Penang, until eventually sunk at the Cocos Islands by the Australian cruiser *Sydney*. While the *Emden* succeeded in sinking some ships laden with supplies, she had no chance against any of our defended ports, and when she was disposed of, the authorities at home began a systematic withdrawal of the British Officers and units in the defended ports, replacing them by Territorial units and officers from the Reserve.

At Singapore, part of the R.E. officers and men were withdrawn in September, 1914, while the British Battalion was brought home a little later and was not replaced by another unit. The only officers left to help Ridout were a Senior Inspector of Works and Lieut. and Qr.-Mr. W. N. Sneesby, R.E., who did good work during the mutiny and contributed many of the details given below. The headquarters of the 41st Coy. and some of the Electric Light personnel remained at Singapore, but the command of the company and the responsibility for the lights were taken over by local Volunteers. In February, 1915, the G.O.C. was ordered home with all the members of his staff.

Ridout was at the time the next senior officer in the garrison and much to his disappointment was left in command of the troops. The writer of this memoir was at the time on his way home from Hong Kong in the ship which took off Major-General Reade, but when our ship arrived at Colombo we heard rumours of a mutiny among the Indian troops at Singapore, which were confirmed at the next port of call.

There was, before the outbreak of war, considerable unrest among the troops in India, fomented by professional agitators, and this unrest had spread to the Indian troops in the Colonies and the Indian Police employed at many ports in the East. No one in Singapore however, anticipated that there would be any organized outbreak. The opportunity was, however, exceptionally favourable. The withdrawal of the R.E. and British Infantry had left Singapore with a very small white garrison, while the Navy had been much reduced in numbers, by the transfer of ships to the Mediterranean and their use in transporting troops from Australia. The Admiral-in-Command had transferred his headquarters from Hong Kong to Singapore but he had only one small British gunboat as a flagship and about half a dozen small ships of French, Russian and Japanese nationality as a fleet. All of these were away from Singapore at the moment chosen for the mutiny, the Admiral, Sir Thomas Jerram, having transferred his office to that of the Naval Intelligence Officer in Fort Canning and hoisted his flag in the Fort.

The mutiny began about 2.30 p.m. on the 15th February, 1915, at Alexandra Barracks. The mutineers, who were joined by some men of the battery of the Malay States Guides, began by shooting some of their own officers, while raiding parties ran through the streets; one party attacked the golf club and the bungalows of Europeans, shooting at everyone they met; another party attacked Tanglin Barracks, cut the military telephone lines and sniped the military hospital, firing volleys into the wards and shooting at any man who happened to come outside. This party also attacked the camp for prisoners of war close to the barracks, where, among others, part of the crew of the *Emden* were interned; this party sniped the guard which was composed of Singapore Volunteers, wounding the sentry and some of the guard. But the Germans refused to join the rebels and instead brought in and attended to the wounded guard. Altogether 42 civilians were massacred in cold blood.

Ridout at once took action, sending out runners to call all available Europeans of the R.G.A. and R.E. to headquarters at Tanglin Barracks, also calling out all local volunteers not already employed and concentrating and arming all available military details. He was much helped by the unexpected arrival a few hours before the outbreak of H.M.S. *Cadmus*, a survey vessel, who at once landed her entire complement to help keep order. Telegrams were sent home

and to India, the latter government despatching a British Territorial battalion from Rangoon. Touch was also made with a Russian cruiser which had just left the port, and put back to render assistance. That evening six officers and other ranks who had been captured under arms were shot as a warning to the remainder but all through the night sporadic fighting continued, the defenders being successful in keeping the mutineers out of the town. The next morning a party of R.G.A. and R.E. with a detachment from H.M.S. *Cadmus* attacked the mutineers in Alexandra Barracks. In this attack the leader of the mutineers was shot in the ankle by one of the first shots fired and after some skirmishing the rebels dispersed. The same morning, detachments from the Russian cruiser and also from a Japanese vessel landed to help restore order but mopping up operations continued for a few days. At the end of a fortnight, the English women and children, who had been hastily put on ships in the harbour, were able to return to their homes. It is worthy of record that these were found intact and in good order, the Chinese servants having combined to prevent looting, a striking testimony to their respect and affection for British rule. A full enquiry followed, by a general officer sent down from India, as a result of which sixty of the mutineers were publicly shot and a leading Arab merchant, who was proved to have been behind a great deal of the subversive influence, was hanged; Singapore and the Malay Peninsula breathed again! It was found at the inquiry that a large proportion of the regiment, probably more than half, were really loyal, but escaped to the bush when shooting began. These surrendered later and after enquiry were re-equipped and rearmed and sent to West Africa, where they did good service.

For his services in suppressing the mutiny Ridout was made C.M.G. He was also given the temporary rank of Brigadier-General and confirmed in the command of the troops. On 1st October, 1915, on completing five years as a Lieut.-Colonel on the regimental list, he was promoted Colonel with the usual antedate given to all R.E. officers, in his case to 15th June, 1914.

*"As O.C. troops, Ridout was *ex officio* a member of the Legis- "lative and Executive Councils of the Straits Settlements and "profiting by his experience of the mutiny, he conducted a cam- "paign against the Sikh Ghadr conspiracy which was in full force "throughout the East at that time.

* Owing to the necessity of censorship in wartime, little has been written about the mutiny. Ridout's own records were unfortunately lost when his house at *Richmond* was bombed during an air raid and his papers in the cellar were damaged by water. In compiling the present account, the writer has received very valuable assistance from Sir Arthur Jelf, who served in the Malayan Civil Service from 1899 to 1925, and was later Colonial Secretary and acting Governor of Jamaica. Sir Arthur was appointed to the Military Service (for Intelligence) from 1917-19 and was on Ridout's staff as G.S.O.3 with the rank of Major. Much of his account of Ridout's activities are recorded in Sir Arthur's own words.

"Under his leadership, Military headquarters in Singapore "became a veritable magnet for information. Hundreds of Sikhs "from San Francisco, who were then passing through Singapore "on their way to foment disorder in India were subjected to close "examination, very often by Ridout personally, who was thus able "to glean invaluable information as to the Ghadr movement. "Several ringleaders were arrested in trying to pass the Singapore "bottle-neck and were held in internment, and this alone came to "reflect the greatest credit on Ridout as the inspiration of the "enquiries.

"In addition to this branch of work, Ridout also devoted himself "to a close study of the Japanese methods of espionage. He was "early convinced, as indeed were most men in the Far East, that "the Army was always supreme in the land of the Rising Sun, and "that the Japanese, who must be continually expanding to find "room for their too-rapidly increasing population, had their eye "on the rich lands of 'Nanyo' (Malaya and Netherlands East "Indies). Ridout therefore set himself to organize counter-espionage "against this potential enemy, and it can be said that the movement "which he originated was of quite first-rate importance in convincing "the British Government of the dangers already arising from the "sinister activities of Japan."

The following account was contributed to *The Times* of 3rd May, 1941, by an unnamed correspondent.

"During the late General Sir Dudley Ridout's service with the Singapore Command in the last War he was in charge of Military and Political Intelligence. Funds were not plentiful; but, by good fortune, a German draft on a Dutch bank in Java fell into his hands. It amounted to well over £100,000 and had been intended for the German propaganda and intelligence service in the Dutch East Indies and in the Far East. It made a welcome addition to the British resources, and enabled Dudley Ridout to extend his network of information.

Though Japan was then the ally of Great Britain, her General Staff and propagandist societies made arrangements to advance Japanese interests in the event of an Allied defeat. The presentation of the famous 21 demands to China early in 1915 showed how the wind might be blowing, for the acceptance of those demands would have given Japan an effective protectorate over China. About the same time Dudley Ridout was informed from Tokyo that an eminent Japanese professor would soon feel an irresistible desire to study Buddhist philosophy in India; and it was suggested that every facility should be given him while his 'studies' were carefully watched. In due course an official Japanese application for this professor to visit India was made through the regular channels. Every facility was given him by the British authorities in India, who also provided him with a secretary thoroughly conversant with the subject of his ostensible interest.

After a few months the Japanese professor expressed a wish to de-

liver a letter personally to the captain of a Japanese vessel at Calcutta. Arrangements were made for him to do so—though a photograph of the letter mysteriously remained in his secretary's hands. The letter was addressed to a member of the Japanese Imperial Family who held high rank in the Japanese General Staff. It contained a long list of the revolutionary centres which the eminent professor had been able to organize in India, together with a code for communicating with them at the right moment.

When the letter had gone, the eminent professor became less cautious. He behaved like an agitator. So he was asked not to leave his place of residence until arrangements could be made for his safe return to Japan. On his arrival at Tokyo the Japanese Foreign Office protested through diplomatic channels against the expulsion from India of so illustrious a Japanese *savant*. In reply the British Ambassador at Tokyo was instructed to hand the Japanese Foreign Secretary a copy of the photograph of the illustrious *savant's* letter. No more was heard of the matter; but Dudley Ridout was congratulated upon the efficiency of his Intelligence Service."

Ridout's good work was much appreciated, both by the Colonial Office and our Foreign Office. He was given the temporary rank of Major-General on 13th September, 1916, received the C.B. in 1918, and was made K.B.E. in 1919. He retained the command at Singapore till 28th April, 1921, when he had completed over 8 years in the Straits Settlements, and was placed on half-pay on the Colonel's list. On the 17th August, 1921, he was selected for promotion to Major-General; this was to fill one of two vacancies on the Generals' list which were reserved for R.E. officers, and Ridout was told that he was expected to wait on half-pay for three years, so as to be available for any suitable vacancy which might arise. But no vacancy occurred and Ridout went on the retired list on 2nd July, 1924.

On retirement he settled at Richmond to enjoy what is often referred to as "well-earned leisure." But Ridout was a glutton for work and was always ready and willing to help his neighbour. He first took an interest in the Star & Garter Home for disabled men, served on the Committee of the Home and was made a Governor, which involved attendance at the Home for one day in each week. Then he joined the Council of the Borough of Richmond and soon took an active part in their proceedings, serving on several Committees and being Chairman of their Roads Committee. He also became Vice-Chairman of the Royal Hospital, Richmond, and of the Holloway Sanatorium, Virginia Water; he was Chairman of the South Middlesex and Richmond Joint Hospital Board, also President of the Richmond branch of the Soldiers', Sailors' and Air Force Families Association and of the B.P. Scouts group and Richmond Division, St. John Ambulance Brigade and in connection with the last, was made an Officer of the Order of St. John of Jerusalem. He was also a Commissioner of Taxes for Surrey and a member of the

Surrey Territorial Association. With this formidable list of responsibilities, it is no wonder that, as he told a friend, he found himself in his later years much busier than he had ever been while in the service.

He kept at work to the last; on 25th April, 1941, he spent a long day at the Middlesex Fever Hospital, came home tired and that night had a sharp heart attack. He was taken to hospital at once, but a second attack came on the 30th April, and he passed away in a few seconds, a happy end to a busy and useful life. He was 75 years of age.

Ridout married at Middelburg, in 1904, the daughter of Mr. C. H. Hutton, of Middelburg, who survives him. He left one son and one daughter; his son is now Major D. G. B. Ridout, K.O.Y.L.I., at present serving on the General Staff; his daughter is married to Capt. Ffinch Mason, East Surrey Regiment.

W.B.B.

BOOKS.

TALKS TO FUTURE OFFICERS.

By LIEUT.-COLONEL DONALD PORTWAY, R.E.

(Heffer, Cambridge. Price 2s. 6d.)

Lieut.-Colonel Portway was charged with the responsibility of control over cadets resident in Cambridge. It is for these cadets that the subject matter of this little book was primarily intended. It contains, however, much that is of value to many who are well launched on their military profession; in fact there are parts of the book which should be of value even to comparatively highly placed officers.

The theme of "Service" rightly runs through every chapter. This is coupled with the need for team spirit. "It is not in isolation, but as a member of a body, that a man finds his fullest self-expression." The author examines the need for at least a proportion of idealism in the Officer's character and background. This need is indirectly stressed in his chapter on the downfall of France, in which he contrasts the necessary reputation of officers for reliability, competence and incorruptibility with the readiness of the French civilian "to make every use of any kind of 'wangle' to secure an advantage over his neighbour."

It is somewhat ungracious to criticize a book which gives evidence of so much experience, thought and even inspiration. Fortunately there is little to criticize, as there is little that is not ostensibly sound. It might however have been an improvement if at certain points advice on a certain line of action had been followed up—for the benefit of the tyro—on suggestions as to how to follow up that advice. For instance, all young officers are told to get to know their men; but, particularly with our present system, some junior officers prejudice their success as Commanders by the methods they adopt in following this advice.

At one point, the author states that the Field Company Section Commander is a field works staff officer to the Infantry Battalion to which he is "usually affiliated." Though when affiliation takes place, it may be true that a Section Commander may most commonly be working with a Battalion, it is certainly not normal for such a degree of dispersion of Engineer Commanders and Troops to take place.

These points are minor ones when weighed against the sound advice based on excellent examples and anecdotes, and expressed in attractive and readable style, which provides the main part of the subject matter. The chapter on "Writing and Reading English" should be of benefit to soldiers of all ranks. We are even now "destroying papers by fire" rather than burning them. The chapter on the downfall of France should commend itself to an even wider public, since unfortunately some of the ailments mentioned are present in our own body politic. The book as a whole is a useful text book for anyone responsible for training young officers or soldiers.

It is clear that the writer is expressing those thoughts nearest to his own heart when he calls for service and idealism, and when he argues that this war is more of a crusade than a clash of national interests. It is when this theme is developed that the writer shows his best work. For this reason, if for no other, the book is well worth careful reading.

"SENTRY."

INCOME TAX FOR H.M. FORCES.

By CAPTAIN G. B. BURR.

(Taxation Publishing Company, Ltd., 83/91, Great Titchfield Street, W.1.) Price 1s.

In this small pamphlet all possible information regarding Income Tax is to be found, and Mr. Staples, Editor of *Taxation*, asserts in a Foreword that the "excellent practical examples and the many useful hints not to be found elsewhere make the book invaluable." Rates of taxation change so frequently that this book, although published so lately as the end of 1940, has already been upset by Sir Kingsley Wood's 1941 Budget, but an amendment slip has been added, bringing the information up to date, in anticipation of the publication of a new edition.

F.E.G.S.

MAGAZINES.

THE JOURNAL OF THE UNITED SERVICE INSTITUTION OF INDIA.

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Persian twilight is a vivid description of the author's part in the campaign against the Bolsheviks in N.W. Persia in 1921. Considering how little is generally known of this small war, and of the part of Iran where it took place, a map would have been a useful addition. One or two other slight criticisms might be made. One is that the sculpture of Darius at Bisitun represents not twelve kings, but ten governors, whose revolts had been crushed, in front of the monarch. Another is that little or no attempt has been made to follow the accepted method of transliteration of Persian place-names, with the result that places are hard to find on a map. These are small points, however, and the author is to be congratulated on a very readable article. He ends on a sad note—though Iran grew to responsibility under the ægis of Britain during and after the Great War, little or no trace of gratitude to us remains.

In the January number of the *Journal*, an officer, rather humbly styling himself "Duffer", described a very successful night operation in Assamese jungles, carried out without the employment of what he styled "those ill-starred horns" (flankers). Using this phrase as a title, R.G. in the current number, combats the view that they can always be dispensed with. "He is surely unwise" he says of Duffer, "to base a general conclusion on the result of a single skirmish."

Financial ramblings in retrospect and prospect relates the dismal tale of how money flies during leave. Most of us are only too familiar with the story. The author holds out no prospect of improvement in the future, when the present war has to be paid for.

Commissioned from the Ranks tells the story of two soldiers in the past, John Shipp, of the 22nd Foot, after serving under Lake, was commissioned in the 76th Foot, but finding himself heavily in debt, sold out, re-enlisted in the 24th Light Dragoons, and was gazetted Ensign in the 87th Regiment, all before he was 32 years of age. Elley enlisted in 1789, and by the end of the Peninsular War was A.A.G. of Cavalry and a K.C.B. He was promoted Lieut.-General in 1837.

Karshish, whose interesting and entertaining articles on learning languages are well-known to readers of the *Journal*, contributes another on Hindustani. While it certainly sounds strange to see a *pandit* of his experience italicize his statement that "There is no need for officers to read and write the Urdu and Devanagri scripts," there is much of absorbing interest in the article.

A blind man sat down is a good Kiplingesque story, though the reviewer must confess that he does not see any connection between the title and the subject matter.

Cairo Conversation relates talk between five officers, four of whom are from the Western desert of Egypt, each of whom says his piece. The Sapper among them tells of his almost daily work of mine-locating, "It is the worst job I know, going out before breakfast . . . and behaving like a poacher surrounded by game-keepers, trying to find mines which don't hurt me personally amongst a lot of other mines which were invented solely to destroy me. In addition to all that, I have to keep looking up to see that no one is stalking me with a Bowie knife. I won't do it again unless I have an infantry escort, and even then I'd have to buy them some rubber shoes to keep them quiet."

Burmese Days is a good description of Burma and its peoples. An interesting item concerns a Mr. J. C. Greer of the I.C.S., who was so much liked and respected by the Shans during his life that on his death in 1915, they made a statue of him, and now consider him one of the *Nats*—tutelary deities—of the region.

Previous numbers of the *Journal* have recorded adventures of one O'Regan preparing for war. In the current number, the hero is actually at war, in Norway.

Floating down the Indus according to Peter Ainslie, is an agreeable and inexpensive way of spending ten days' leave, shooting duck being an additional attraction. Those of us who have seen the river only at railway and boat crossings will certainly envy the author his trip.

F.C.M.

THE MILITARY ENGINEER.

(*March-April*, 1941.)—*Assault of a Fortified Position.* By Captain W. Whipple. The writer has made a careful study of the methods employed by the Germans in reducing the fortifications encountered in the recent campaigns in Holland, Flanders, and France. In the storming of Eben Emaël and the Maginot Line forts the most striking points about the tactics employed are the use of flat trajectory anti-tank and anti-aircraft gun-fire and the employment of highly trained pioneer or engineer troops with explosives. These methods have led to the reduction of fortifications that would have been virtually impregnable by a normal artillery and infantry attack.

This does not mean that field or permanent fortifications are out of date, but merely illustrates that success can be achieved by a determined, daring, intelligent and well-trained force against an inadequately defended position. The question is not whether or not fortified localities should be established, but rather when and how they should be established. The Mannerheim line across the Karelian Isthmus is an extremely good example of the use of fortifications to defend a strategic defile. In the case of the Dardanelles or the Suez Canal the importance of fortifications to multiply the powers of the defender and take advantage of the tactical value of shore lines, is clear.

A fortified position should only be attacked when its passage is necessary to obtain a vital objective and when it is impossible to outflank the line or find a weaker spot. After the envelopment of the main defending position, successive phases in the operation are: (1) the penetration, (2) flanking attacks to expand the gap, (3) the exploitation of the penetration, with the greatest possible speed and force.

The Germans place great reliance on anti-tank obstacles. These obstacles are suitable for narrow defiles or small objectives of permanent military importance. They are cumbersome and expensive, and should only be planned for cross-country use in the case of deliberate fortifications. The writer describes two types of shell-proof automatic weapon emplacement, one of which is laid down in the American Engineer Field Manual, but points out that the materials for it weigh about 250 tons and even then it will not take the new model 37 mm. anti-tank gun. At present there is no satisfactory portable anti-tank obstacle except the mine.

Further points dealt with are wire entanglements, observation and communication facilities, heavy field artillery, anti-tank and anti-aircraft guns, incendiary devices, small arms fire, smoke and tanks. Engineer weapons in the assault include Bangalore torpedoes for breaching wire, and prepared charges of T.N.T. for use against emplacements. By the repeated use of these charges, employed in the right places, it has been found possible to destroy a 12-inch steel turret, which would normally be proof against almost any artillery.

The writer goes at some length into the Tactics of Assault and concludes with the use of Engineers in Assault Operations. This class of work requires highly trained men. The Germans complained that two years' training was insufficient for an engineer soldier, and even so, they do not assign units indiscriminately for assault work, but only utilize specially selected men.

Field Training in Engineer Operations.

Captain Auerbach describes how, as an item of field training for his company, he

built a bridge of 12-ft. span, and subsequently demolished it. The bridge had concrete abutments and 12" by 3" timber roadbearers with 2" decking. For the demolition, charges of ammonia dynamite were used. First the roadway was destroyed, then one abutment. The bridge was then rebuilt, using the old timber as far as possible, and, in a final phase, abutment and roadway were blown up simultaneously.

Engineers in Battle. By Captain P. W. Thompson.

This is a continuation of a series of articles, giving accounts of Engineer actions during the recent campaigns in Europe, taken, respectively, from the *Vierteljahreshefte für Pioniere*, and the *Militärwissenschaftliche Rundschau*.

The first portion is part of the diary of the 57th Engineer Battalion, belonging to one of the German Panzer divisions, during the campaign of 1940 in Belgium and France. One of the first important tasks allotted to the unit was to ferry assault waves of infantry across the Meuse on the 13th May, and then to construct a bridge to take the tanks of the division across. The launching of the engineer assault boats was preceded and covered by a terrific dive-bomber and artillery attack on the enemy positions; its success is an illustration of the decisive advantage which a complete control of the air gives, even in the face of great obstacles.

By the 17th May the shock elements of the Division had reached the Oise east of St. Quentin, and had seized several crossings in that vicinity. The bridges appear to have been taken intact—an example of the reluctance of French civil officials to permit the destruction of bridges likely to be used by refugees.

For a fortnight from the 23rd May the battalion took part in the operations in Flanders, mainly against the British, and, after that, it went to the Champagne country, and was employed on miscellaneous jobs until the armistice on July 25th.

The following is reminiscent of an incident in the Napoleonic wars:—"On the night of June 19-20, advance elements of the Panzer division—including an Engineer reconnaissance party—entered Epinal. Here the Engineers saw their last real fighting, and suffered their last losses. The action occurred at one of the important bridges which was being strongly defended, which had been prepared for demolition, and the roadway of which was blocked by mines. An Engineer assault detachment was given the mission of seizing the bridge, intact if possible.

The Engineer lieutenant in charge of the detachment managed to work himself to the vicinity of buildings very close to the near end of the bridge. He found the bridge to be covered by machine guns emplaced in houses across the river. It developed that the guns would remain silent during intervals when refugees would be allowed to cross the bridge; but that they would open up on sight of a German uniform. Thereupon, the Engineer lieutenant went back and obtained a coat, hat, and cart similar to those worn and used by the refugees. In this disguise he drove up to the bridge. There, he left the cart, walked on to the bridge and suddenly began throwing mines into the river. It is not clear just what prevented the French from pulling the switch and demolishing the bridge when they saw what was happening (perhaps all the refugees were not yet across). In any event, what they did was to take the lieutenant under fire. He was severely wounded, but none the less managed to clear away the mines, and stagger back to his own comrades. He died later in the day; and still later on the same day was awarded the Iron Cross, posthumously."

The second part of the article describes the operations connected with the crossing of the Albert Canal, and the part taken by the 3rd Company of the 19th Engineer Battalion.

In this case there was no preliminary dive-bombing attack, but the crossing succeeded through the sheer boldness of its conception. It was undertaken on a dark night; the lieutenant in command, with his detachment, crossed the canal, which was 50 yards wide, in four small pneumatic boats, cutting their way through the wire on both banks. The Belgians, who were holding the emplacements on the west bank, put up no resistance, and the crossing was secured.

The operation was rendered all the easier by the fact that the Eben Emaël fort,

the key to the Albert line, had been captured on the previous day, and the positions behind the line had become untenable.

Training a Selectee to be an Engineer Soldier. By Captain Johansen. Two Engineer Replacement Centres are being organized and expanded to their eventual full size: one at Fort Belvoir, Virginia, and the other at Fort Leonard Wood, near Rolla, Missouri. The organization of each provides for a cadre of 250 officers and 10,000 men. Courses are held for officer instructors and N.C.O. instructors. The course for men (selectees) lasts 12 weeks. The object of the training programme is to provide trained Engineer replacements, particularly from among selective service men. The course will harden and discipline them and prepare them for the duties of an engineer soldier. On completion of their training the selectees will be sent all over the United States and posted to Army Engineer Units to serve the balance of their year of selective service with the Corps of Engineers.

Fort Leonard Wood, Missouri. By Lieut.-Col. F. W. Herman. While the previous article deals mainly with Fort Belvoir in Virginia, this article describes the second, and smaller, Engineer Replacement Centre at Fort Leonard Wood. The War Department has acquired a site, covering 100 square miles, forming part of the National Forest, 1,100 feet above sea level.

The new cantonment, which is to be completed in the spring of 1941, will accommodate, in addition to the Engineer Replacement Centre, the 6th Division, a Field Artillery brigade, a group of army troops, including an engineer pontoon battalion and other units. A low dam will be built across the Big Piney stream to form a pool for pontoon training.

Peru. By Colonel Ristedt. A general description of Peru, including its physical features, climate and mineral resources, early history, communications and military forces.

Research in Camouflage and Concealment Facilities.

The Camouflage Section of the Engineer Board was formed in 1937, and it has, since then, increased in size and in the scope of its activities. Experiments are being made with the concealment of anti-aircraft and field artillery guns. Photographic tests made from the air at Fort Belvoir show that it is necessary to consider the question of the camouflage of buildings as soon as the site is selected and the buildings have been laid out, and not to wait until they are completed.

As regards materials, those principally used until about four years ago were burlap, fishing nets, chicken wire and oil paints. Of these, all but the fishing nets have been replaced by more suitable substitutes. Powdered casein paints have taken the place of oil paints, being cheaper and less inflammable. A new type of chicken wire, known as "straight wire," has taken the place of the old hexagonal mesh. It is lighter, cheaper, and keeps its shape better.

An All-Purpose Camouflage Net.

Captain P. Rodyenko considers that the present camouflage net (36 ft. by 44 ft.) is too bulky and heavy and is difficult to handle, besides having other disadvantages. He suggests a smaller net, 12 ft. by 24 ft., two or more of which could be joined together. In the subsequent discussion his proposal is somewhat unfavourably criticized.

Handling Hydrocarbons with Safety and Profit. By W. Reed-Hill.

Evaporation is a cause of heavy loss as well as of danger in the handling of fuel oil. The chief cause of evaporation is the exposure of the volatile oil's surface to air in a partially filled tank.

In this article Mr. Reed-Hill shows how the problem can be met in the case of the lighter oils, *viz.* those of 18° Baumé and upwards. These hydrocarbons float on water without any mechanical mixing or emulsion, provided they are kept hard up against the top of the tank. This can be done easily by means of a water riser open at the bottom inside the tank, to set up the necessary hydrostatic head. As the oil is drawn off, water, which may be fresh or salt, takes its place at the bottom of the tank. The

vents, ordinarily provided for allowing for expansion and contraction, are not used. There are simple controls, operated electrically. These controls can be used to prevent spillage, even in small tanks.

(*May-June, 1941.*)—*Modern Military Obstacle Technique.*

In this article, Major W. E. Potter describes the various types of obstacles commonly in used.

Anti-tank mines provide the best obstacle; a large mine is worth the extra transport entailed, as compared with the standard type. Craters and ditches, if properly constructed, can be very effective. Pile and rail obstacles should consist of at least six rows. Log obstacles are likely to be used extensively. With larger trees a log ramp is suggested; with smaller ones a vertical log wall. Wire rolls are of little use. Abatis, in conjunction with other obstacles, is useful. Personnel mines, worked by a trip wire, will usually be employed in connection with heavy permanent obstacles.

Engineers in Battle. By Captain P. W. Thompson.

This is the continuation of a series which began in *The Military Engineer* for January-February, 1941, and contains accounts taken from German military journals relating to (1) Action between West Wall and Maginot Line, (2) Ferrying on the Seine, (3) Pontooning on the Seine. They contain nothing of special interest.

New Portable Timber Military Bridge. By Major T. C. Combs, and Captain B. Benioff.

Officers of the 349th Engineers have designed and constructed a portable timber bridge, adaptable to any span up to 72 feet, and made up in 12 ft. sections. It is designed to carry an H-10 load, *i.e.* a 10-ton truck (wheels 14 ft. centre to centre, 2 T front, 8 T rear), preceded and followed by 7½-ton trucks (wheels 14 ft. centre to centre, 1·5 T front, 6 T rear), at 30 ft. intervals. The roadway is 10 ft. wide. The truss is of Pratt and Howe type, the parts are interchangeable and reversible. The working stresses allowed are much higher then those in ordinary practice, as the bridge is not likely to be in use for a long time at a stretch. The bridge is carried on four trusses, 6 ft. deep, boxed together in pairs, each box being 2 ft. wide. The timber used is Douglas fir: all the bolts used are ¾ inch. Shear plates are used at all joints.

All details and dimensions are given in sketches accompanying the article. The method of putting the bridge together, and the various methods of launching the girders are described. Tests that have been carried out have given satisfactory results.

As regards the military value of the bridge, it is not claimed that it is up to the standard of its steel counterpart in all respects. But it has the advantage that it can be "knocked down" into its component parts, and assembled into standard 6 ft. by 2 ft. by 12 ft. sections where required. This would mean a saving in transport. It would, of course, be invaluable if steel were not available.

Engineer Board Notes. Development of Floating Equipment.

Owing to the raising of the weight of the medium tank from 23 tons to 25 tons, the designs for a floating bridge have been scrapped, and new ones have been worked out. The new equipment is being tested.

A new method has been adopted for the transport of the 10-ton equipage. A 250-ft. bridge unit is now transported on 6 semi-trailers and 4 truck-dolly units.

The advantages of ferries and rafts, employed for the purpose of getting heavy equipment across a river prior to completion of a bridge, are dwelt upon.

Development in Design of Pontoon Bridges. By Captain D. E. Swift.

The requirements of a pontoon bridge are as follows:—

(*a*) It must carry the designed load with a small factor of safety.

(*b*) It must be easily transported and occupy a minimum of road space.

(*c*) It must be easily unloaded at the bridge site.

(*d*) It must be so designed that it can be speedily constructed with a minimum of skilled personnel.

(*e*) It should be easily maintained and reloaded.

The pontoon equipment of the United States Army consists of the 10-ton pontoon bridge, model 1938, and the 25-ton pontoon bridge, model 1940.

The 10-ton bridge can be reinforced at the hinge sill to carry 13½-ton light tanks, and will carry 20-ton loads by adding a boat to each bay. One unit of bridge consists of 4 trestles, 12 pontoons, and the floor system. It contains 1,067 individual parts and provides about 250 feet of bridge.

The 25-ton bridge is of the same basic design as the 10-ton bridge, but on a heavier scale, and can be reinforced to carry 45-ton loads.

The increased loads of guns and new light tanks will require a re-designing of the 10-ton bridge.

As regards transport, it has been possible to reduce the 33 vehicles originally required for the bridge to 10. In the new scheme of transport, two pontoons are placed upside down on one semi-trailer, one above the other.

The present bridge is not adapted to rapid construction. It has only been improved in minor details since 1869, and requires well-trained troops to put it together quickly.

In order to increase the efficiency and speed of bridge construction, the writer suggests improvements on the following lines:—

If a floor system can be devised so that a complete bay of bridge is launched with each boat, and becomes part of the bridge when the boat is anchored in place, the speed of construction would be greatly increased. Two continuous box girders, one for each wheel track, with integral treadways, would seem to offer a solution.

A continuous box girder would have to meet the following requirements:—It must be constructed in sections connected by moment-resisting joints. No section should exceed 500 lb. in weight. Joints must be simple and strong. Provision must be made for laying a planked flooring across the girders, and clamping it securely. Pontoons should be spaced sufficiently far apart not to obstruct the waterway.

The design proposed is as follows:—Each girder section to be 16 ft. long, 3ft. wide and 2 ft. deep. The structure should be designed to carry a 20-ton concentrated load, allowing 30% for impact. The girder may consist of any of the following:—steel trusses, aluminium rolled shapes, stainless steel tubing, or wood trusses with steel connections.

The writer describes, with illustrations, the general lay out of the proposed bridge, the arrangements at bridge ends, and alternative methods of loading and hauling the equipment. The advantages claimed are: the number of individual parts can be reduced from 1,067 to about 100, the number of operations from 2,500 to 400. The load capacity would be increased to 20-tons, and by reinforcing, to 30 or 40 tons.

A.S.H.

REVUE MILITAIRE SUISSE.

(*Feb.*, 1941.)—*Emigration et défense nationale.* By Major de V. Describes the effect on national defence of the emigration of Swiss subjects, which is on the increase. In a previous article (Dec., 1940) the author showed how the excess of births over deaths was steadily diminishing, and he now calls attention to the serious falling-off of population. But, since the cry for more living space on the Continent persists, is it a bad thing that emigration to new pastures should continue?

De l'emploi du lance-mines dans le déclenchement artificiel des avalanches. By Lieut. Gabereli. An interesting article, illustrated with photographs, describing the use of mortars for dislodging avalanches, and removing their danger to road and railway traffic. This method has its military uses too, as a means of blocking communication. It would be simple and effective. It is necessary to study the position of the snowfield, the formation of the ground, and the probable "cone" of displacement.

Commentaires sur la guerre actuelle. At the time of writing, the commentator had little to say of the operations in Albania. The Greek advance was slowly proceeding, and the Italians were giving ground, but no particular feature was noted.

In Libya, the commentator remarks that the British had rapidly adapted to desert warfare the German methods of employing mechanized units. The striking success of the British forces had not yet been brought to a halt by the lengthening-out of communications.

The operations in Eritrea, Abyssinia and Italian Somaliland are dismissed in a few lines.

(*March, 1941.*)—*Réflexions sur la campagne de France.* By Captain Bauer. The first instalment of a candid review of the policies which led to the French débâcle of 1940. All the lessons of 1914-18 were thrown away one by one by the succession of political leaders who seem to have been more disposed to grind axes of their own than to stabilize their country against any return of invasion. Forty-four different Governments took their turn between 1920 and 1940; they enjoyed an average life of less than 5½ months. Yet the French people have been unable to shift their present rulers, who are so treacherously betraying their true interests.

It is chiefly in the naval and military spheres that this article exposes the decline of French policy. Successive changes in the laws of military service reduced the period of service in the active army from 3 years to 2 years, then to 1 year, and back to 2 years in 1936. The effective strength of the regular Army was lowered from 750,000 to 450,000. On mobilization, the army contained a much higher proportion of reserve divisions than in 1914. At the beginning of the last war, Joffre had 10 cavalry divisions and 84 infantry divisions. Of the latter, 47 were regular, 25 were reserve, and 12 were Territorials. But Gamelin had 80 infantry divisions, 5 cavalry divisions, 3 light mechanized divisions, and 3 armoured divisions. Of the 80 infantry divisions, only 31 were regular, 36 were reserve, and 13 were immobile fortress divisions. This was the army which had to face Hitler's multi-mechanized force.

The cadre of officers was dropped to 28,000. But worse than all this, was the sapping of the French will to work, to prepare for the obvious German attack. The French reply to the German 54-hour week was the 40-hour week of M. Blum. The French output of aircraft in 1937 did not exceed 30 machines a month.

The democracies talked too much about the freedom which they did so little to safeguard.

Emigration et défense nationale. By Major de V. The conclusions of last month's article. The author summarizes the damage being done to Swiss national defence as follows:—(*i*) the birth-rate does not compensate the annual emigration, (*ii*) each Swiss emigrant is replaced by a foreign immigrant, (*iii*) the expatriated Swiss becomes rapidly denationalized and absorbed by his new country, (*iv*) the emigrants are chiefly agriculturists and skilled workmen.

The author deplores the lack of Government action to check the flow.

Les cuirassements mobiles en montagne. By Captain Moser. This is a translation from the German. It has always been held that a mountainous country would be impracticable for armoured vehicles, but the author thinks that there is great scope for the judicious use of such weapons. It is true that the blocking of defiles and gorges can put a stop to the march of mechanized columns, but if a break-through has forced a gap in the defences, individual tanks may be able to penetrate to the rear and do the damage which the Germans set such store by. This optimism seems to be unwarranted, if one reflects on the ease with which a mountain-road can be rendered impassable. A tank which cannot pass an obstruction has to go round it, but if a mountain wall stands on one side and a gorge on the other—the usual features of mountain-roads—the predicament of the tank is self-evident. A stationary tank is a target artillerists dream of; but the gun must be there.

For defence, there is much more to be said for the use of tanks as mobile gun cupolas.

Commentaires sur la guerre actuelle. In the swiftly moving drama, it is difficult to carry the mind back to the situation to which these monthly commentaries apply. Their author limits himself—as indeed he must—to a bare outline of the operations.

The campaign in Albania is still (in the March review) noticed under the heading of Greece. The presence of German troops in Bulgaria is beginning to make itself felt, and the Greeks are not pressing forward too far into Albania.

In Libya, the arrival of the German North African Corps at Tripoli is remarked, as an indication of the increasing aid being given to Italy.

The rapid advance of the South African troops into Italian Somaliland has begun to receive attention; and the recapture of Berbera on March 16th is the final note.

No comment is made on the remarkable rapidity of our forces in East Africa, a feature which will become the subject of much attention when the historians get to work. A very cautious tone runs through these commentaries.

(*April*, 1941.)—*Les opérations sur le front ouest.* By Lieut. Jaggi. An outline of the German Army's "blitzkrieg" against Holland, Belgium and France. Some details are given of the grouping of the German and French Armies, but there is not yet enough information to show the relative strengths of the Armies. Hitler, in his speech in the Reichstag in July, 1940, affirmed that the object of his operations was the complete destruction of the Anglo-French forces. The Schlieffen plan was reversed, the weight of the blow being concentrated on the left of the front attacked, while the rush at Holland disguised the main objective. It was a thorough plan, and worked out to perfection, from the German view; only the stubborn British refused to be eaten up, and managed to fight their way back to the beaches, baulking Hitler of one of his chief prizes.

The German Armies were in three groups, of which the two on the wings had two armies each, and the centre group had five. It was this centre group which broke through at Sedan and overwhelmed General Corap's Ninth Army.

The Dutch Army, about 400,000 strong, was caught in the whirlwind before it could get its defences properly manned or its inundations complete. The Belgian Army, 600,000 strong—about twice the size of the army of 1914—was likewise caught before it could concentrate. Its divisions were overwhelmed piecemeal. Once again, Liège was captured by a *coup de main*; this time by parachute troops dropped in the important bastion of Eben-Emaël, to the north of the fortress. In spite of their small numbers, these parachutists held on for twenty-four hours, until reinforced by a battalion of engineers.

In Holland, it was the capture of Rotterdam by parachutists and air-borne troops which broke up the Dutch resistance. These advanced troops were quickly reinforced by motorized infantry and machine-gunners, who were able to reach the city in spite of all the preparations for obstructing roads. All the schemes of defence which had been prepared in these countries were thrown out of gear by the confusion caused in the rear by the air-borne detachments. It is this lesson which we ourselves must learn thoroughly. We have had the fortune to be allowed time to learn the German methods; we must be prepared to eat up his detachments as fast as they land. They cannot, at any rate, be reinforced by motorized infantry until these come over by sea.

The events of May, 1940, are too well known to need recapitulation here. There is still too little solid information available to show exactly why the Allied plan crumbled so easily, or why Weygand was unable to counter-attack as we expected him to do. A paralysis set in among the French, and the British Army was left unsupported on either flank. Very little reference is made in this article to the British force, and no mention at all is made of the fact that the bulk of it made good its escape from the débâcle.

The real history of these days will make different reading.

Le tir contre chars. By Captain Nicollin. Relates to instruction in an improved aiming device used by the Swiss Army for anti-tank weapons.

Commentaires sur la guerre actuelle. The German attack in Libya is the first subject of this month's commentary. Swift as had been General Wavell's success over the Italians, the German reversal of the situation was even swifter. But it is at least remarked that General Wavell had had to withdraw the greater part of his troops from Cyrenaica to go to the help of Greece. How came the Germans to transport such considerable forces across the Mediterranean under the noses of the English, asks the commentator. Evidently, he expects something more striking to eventuate than the stalemate which has followed General Rommel's rapid blow.

In the Balkans, he observes that the situation changes so rapidly from day to day that his review is overtaken by events. The lightning attack on Jugo-Slavia bore some resemblance to that on Poland. Paralysis of the enemy's High Command by destroying the means of communication is the Germans' first objective, and it must be said that there have been plenty of examples of the success of their strokes.

One significant sentence occurs in this month's comments:—"It is always in "terrain considered impracticable for the assailant that great events are brought "about which have an influence on the final decision." No troops must consider themselves safe from air or tank attack.

W.H.K.

BELLONA.

(March and May, 1941).

THE 10th POLISH MOTORIZED CAVALRY BRIGADE

in the Polish-German 1939 Campaign.

The author, a staff officer of this Brigade, relies mainly on his own reminiscences supported only by little documentary evidence available at the present moment. Here only the first part of his study, i.e. that dealing with the fighting during 1st to 5th September, 1939, has been condensed in English. However, a short summary of the further happenings is added at the end of this account.

* * * * *

Polish 10th Motorized Cavalry Brigade was composed of two motorized cavalry regiments (24th Lancers and 10th Horse Rifle). Its total war establishment included besides that: H.Q., Traffic Control Platoon, Signals Squadron, Reconnaissance Group, and A.T. Group (18 guns), a Mechanized Field Battery (four 75 mm. guns and four 10.5 cm. Howitzers), a Light Tank Company (Vickers), a Scout (T.K.) Tank Company, an Engineer Battalion, a 40 mm. A.A. Battery and the services comprising: supply park, medical platoon, armament park and M.T. Column.

As we see, this Brigade could not properly be called an armoured mechanized unit similar to those existing in the German, French and Russian armies. Its tank equipment was numerically insignificant and did not exceed that of an infantry or cavalry unit provided with rather inadequate means of armoured reconnaissance.

As a matter of fact it was a purely motorized unit of somewhat over 2 infantry battalions' strength, supported by one field battery and one light tank coy. This unit was provided with means (commanding, signals, engineers, A.T. and A.A.) allowing of the execution of independent tasks necessarily limited by the inadequacy of numbers and armament, which although strong in defensive weapons (M.G. and A.T.) was poor as far as offensive arms (artillery and tanks) were concerned.

The Brigade was also very scantily provided with efficient means of reconnoitring. Its reconnaissance group included only two T.K. Tank platoons, the rest being composed of a mechanized rifle squadron (infantry on motor trucks) and of a motor-cycle platoon. As for the two motorized Cavalry Regiments, they had only one motor-cycle platoon each. The experience has proved that motor-cyclists are not well suited for independent reconnoitring tasks; they are only a welcome addition to an armoured reconnaissance which, as far as the Brigade was concerned, was very insufficient.

The Bde. Commander fully realized that and, consequently, at the very beginning of action, distributed the Bde. T.K. Tank Coy. amongst his two Cavalry Rgts., giving one platoon to each, and thus reducing the armoured unit at his direct disposal to only one (Vickers) Tank Company. That, of course, still further weakened the Brigade's offensive power.

The mechanized transport equipment was composed entirely of large 1½-2 tons road vehicles. It enabled the Bde. to move at a great speed beyond the fighting region, that speed, however, was very considerably reduced in enemy's proximity, as the Bde. was unable to quit the roads and to move across country. Also the flexibility of columns was unsatisfactory, making every change of direction or empty car manœuvring a rather difficult and dangerous operation.

The mobilization of the Bde., although started as early as in March, had nevertheless not been carried through with full efficiency. It had been achieved by successive, not always well concerted, stages; the batches of reservists were changed several times; the armament and equipment attained full war establishments only after the declaration of general mobilization (30th August).

By the end of August the Bde. occupied the region close west of Kraków and was destined to be an Army reserve at G.H.Q. disposal.

As the hostilities broke out on the 1st of September early in the morning, the Bde. against all expectations, received its first fighting mission at 10 a.m. that day. The order stated that a strong enemy armoured group in the south, after having crossed the Tatra mountains and pushed back our frontier protecting troops, was advancing in the direction of Rabka, Skomielna, Biala and Jordanów (see map). The 10th Cavalry Bde. reinforced by the 1st K.O.P. (Frontier Guard) Rgt., already in contact with the enemy within Rabka-Jordanów region, received the mission: Not to allow the enemy armoured units to debouch from mountain defiles into the plains of Myślenice-Dobczyce region and to attack the rear of the Polish Kraków Army.

Having received this order O.C. Bde., (Colonel Maczek) decided to march in two columns: the western through Kraków, Myślenice, Pcim, and the eastern through Wieliczka, Dobczyce, Kasina Wielka.

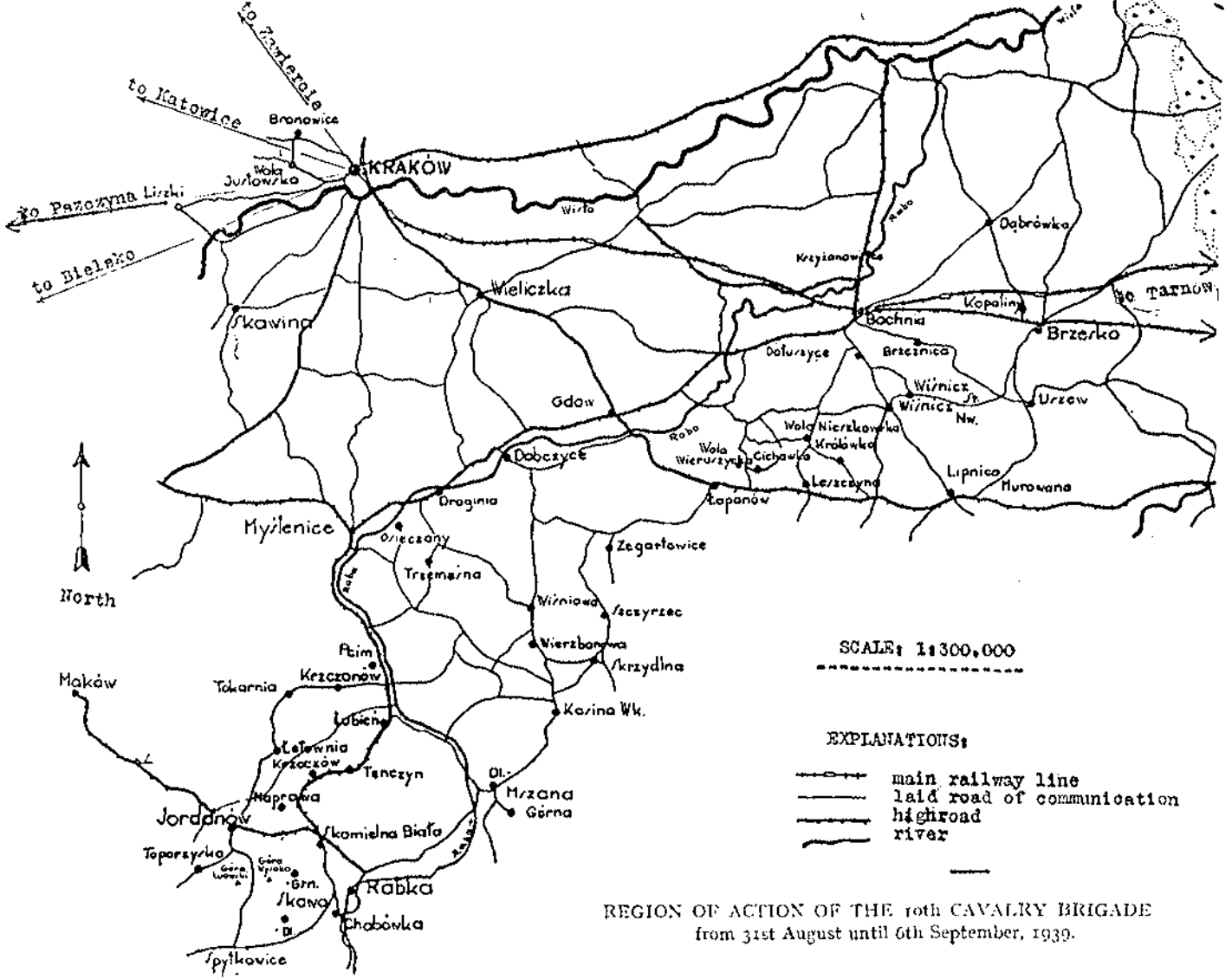
The main body of the Bde. marched on the western axis, only the 10th Horse Rifle Rgt. with one T.K. Tank platoon and a Sapper platoon marching on the eastern one, with the mission of reaching Mszana Dolna and of protecting the Bde. towards the direction of Rabka.

As for the other Bde. units, one squadron of A.T. guns (9 guns) was directed to Skomielna Biala to reinforce the 1st K.O.P. Rgt. and to be at the Regimental Commander's disposal. The reconnaissance Group had to march to Krzeczów and the 24th Lancer Rgt. with artillery, tanks, the rest of the A.T. Group, the Engineers and the A.A. battery into the region of Lubień-Pcim.

The units reached their destinations about 6 p.m. In the meantime O.C. Bde. established the following facts: Germans were advancing in two columns—one through Jablonka, another through Nowy Targ, the former column seeming to be the stronger one. Owing to the surprise character of the German attack, the destructions prepared beforehand within frontier zone could not be carried out. At 4 p.m. (1st of September) the situation was as follows: the K.O.P. Rgt., after having opposed the enemy's advance since dawn, was occupying the mountains south of Jordanów (Góra Ludwiki and Wysoka). In the west, Polish troops held the Maków region, in the east there were practically no Polish troops at all.

The Brigade Commander's decision was: to mass his main forces in Jordanów-Rabka region, to hold the Wysoka and Góra Ludwiki ranges and to organize a night attack on Spytkowice, where considerable concentration of German mechanized troops has been reported.

In accordance with that decision the 24th Lancers, one Coy. of K.O.P. Infantry and one A.T. squadron, were entrusted with the defence of Jordanów sector. The main of the K.O.P. Rgt. with some A.T. guns had to defend the Rabka sector. The artillery

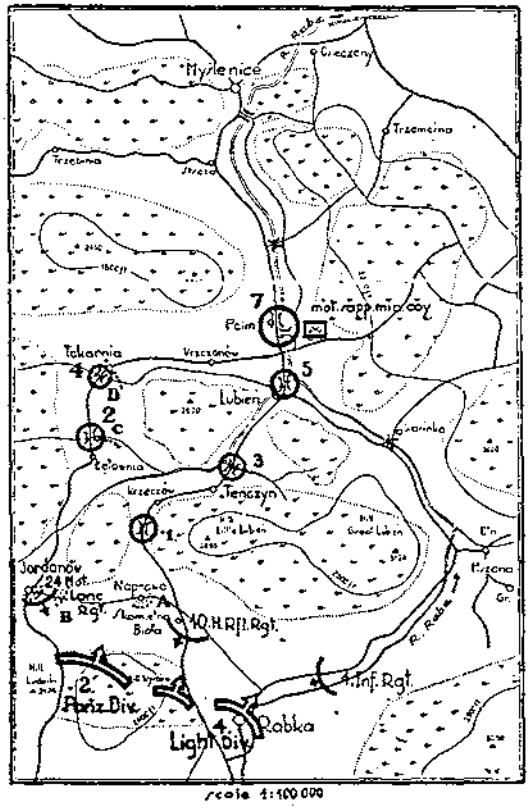


REGION OF ACTION OF THE 10th CAVALRY BRIGADE
from 31st August until 6th September, 1939.

took its positions on the southern fringe of the village Naprawa, having as mission to support the defence of Wysoka. The reserve was formed by the Reconnaissance Group at Krzeczów and the 10th Horse Rifle Rgt. at Lubien. Bde. H.Q. was at Krzeczów, the Commander's fighting post at Skomielna Biala.

The operations were started on the following night (1st-2nd September) by the already mentioned night attack on Spytkowice which, however, miscarried, owing to unexpected delay in its execution and the resulting failure to surprise the enemy. During the same night the Polish defence position was organized.

The German attack developed next morning (2nd September), its main effort being directed against the Góra Wysoka and Góra Ludwiki positions. The first assault, made after artillery preparation by about 200 enemy tanks, was repulsed with heavy



German losses (at least 30 tanks). The attack was repeated at 3 p.m. after new and more careful artillery preparation, directed against A.T. guns and M.G. already reconnoitred. This time, after stubborn fighting, the enemy succeeded in trampling down the Polish Artillery observation posts, and subsequently, in conquering Wysoka. A counter-attack executed by two squadrons of Lancers could not restore the situation. Consequently our troops defending Wysoka retreated (in most cases after the enemy tanks had passed over them) and clung to the outskirts of Jordanów. The enemy, however, did not push farther but began his regrouping for a new attack on Skomielna Biala. A rather half-hearted fighting reconnaissance made by the enemy in that direction was stopped without difficulty by our Bde. Reconnaissance Group

advancing in the direction of Skawa Dolna. At dusk our artillery fired for some time against the enemy tank concentrations. Thus ended the first day.

The fighting experience acquired enabled us to draw the following conclusions:

It was established beyond doubt that the attacking German troops belonged to the 2nd German Armoured Division of General List's Army. It was also realized that notwithstanding the enemy's huge superiority, especially in aircraft, tank arm, and artillery, we were quite capable of offering him a very serious resistance.

The soldiers fought splendidly without any trace of the inferiority complex or tank fright. Especially our A.T. Arm proved to be excellent. Several enemy tanks were scored by some of our 37" guns, the crews of which fought literally to the very end until their guns have been hit by shells or trampled over by tanks.

In spite of heavy casualties the morale of Polish troops strengthened because they acquired confidence in themselves and their arms.

As for the methods of the enemy tank units, they were mainly those of terrorism consisting in machine-gunning of any possible concealment even if nothing indicated any enemy's presence there—also in setting on fire every object in front of them. Both methods had their reasons. The indiscriminate firing at great expense of ammunition increased the safety of tanks and uplifted the morale of their crews. The incendiarism signalled the line attained by German troops and terrorised the civilian population into indiscriminate flight, obstructing communication and supply. Both these methods ensured also against possible ambushes and lighted the fore-front, thereby making our night raids more difficult.

As the result of the 1st day's fighting the enemy conquered the heights, giving him advantageous sight into Skawa river valley and the facility of its penetration. Besides, his artillery got its fire ranged on our positions on the outskirts of that valley. Thus the enemy, superior in force, was in a favourable situation enabling him to play against us his strongest trumps: the artillery and the tanks.

The Jordanów-Rabka line offered 3 possible lines of further advance towards the rear of the Polish Army of Kraków:

1. Jordanów-Krzczonów-Pcim.
2. Skomielna Biala-Pcim.
3. Rabka-Mszana Dolna.

All these routes are defiles leading between wooded heights and debouching into the Myslenice-Dobczyce line.

The Bde. Commander's decision for the next day was: to defend these three defiles by 3 independent groups. The enemy should be prevented from reaching the Lublin-Mszana Dolna line. Mobile reserves for purpose of intervention should be formed.

Consequently the Jordanów-Tokarnia direction had to be protected by the 24th Lancers supported by a squadron of A.T. guns, that of Naprawa-Lublin by the 10th Horse Rifle Rgt. and the whole artillery, that of Rabka-Mszana by the 1st K.O.P. Rgt. with an artillery troop of its own and 2 platoons of A.T. guns. The Bde. reserve consisted of the Tank Coy. and the Reconnaissance Group, both placed within the Tenczyn-Lubien region.

The German attack on the next day (3rd September) started late, after systematic artillery preparation, preceded by armed reconnaissance, as it was on the previous day. The fights between Polish and German Reconnaissance troops resulted in the capturing of some German prisoners and documents, the examination of which disclosed the presence of not only the 2nd German Panzer Division but also of the 4th Light Division in the eastern part of the Bde. sector.

The enemy's main effort was directed against the positions held by the 10th Horse Rifle Rgt. and those of the 1st K.O.P. Rgt. The German aircraft took part in the attack and bombed the fighting troops as well as the reserves. The result was, however, negligible, only the Bde. H.Q. lost a few killed and wounded.

On that day all Polish units accomplished their assigned missions although some

critical situations had to be mastered. The 10th Horse Rifle Rgt., menaced by an enveloping movement, had to execute several counter-attacks and close fighting ensued. Finally the intervention of Polish Tank Coy. restored the situation. There was also a false alarm about "enemy tanks in the rear" which, however, did not lead to any kind of panic and was soon rectified. The third and most serious incident was a strong attack of enemy tanks made late in the afternoon against the 1st K.O.P. Rgt., some companies of which suffered heavy casualties. Finally, however, the Rgt. succeeded in holding strongly Mszana Dolna and the Lubien-Mszana road.

In the evening the 24th Lancers were ordered to fall back on Letownia, leaving at Jordanów some contact troops. The 10th Horse Rifle Rgt. held Krzeczów. The Bde. reserve, composed as on the previous day, was placed within Lubien-Krzczonów region.

Our casualties, with the exception of the 1st K.O.P. Rgt., were not severe. The enemy lost about 10 tanks, some M.G. and prisoners were taken.

In the evening of the 3rd September an Army Order headed "Outlines for the retreat" was received. It placed the Bde. under the orders of the commander of the newly created Southern Army Corps. The necessary liaison with the new Commander could, however, not be made operative before the next morning. In the meantime the Bde. Commander, assuming that his mission of protecting the southern flank was to remain unchanged, decided to act under the following considerations.

The Mszana-Kasina direction offered to the enemy the best prospects of success and the best conditions for employment of tanks and artillery, whereas on the Myslenice road, having the character of a mountain defile, he would have to cope with an increasingly difficult terrain. Besides, the Dobczyce direction debouched on the rear of the Army Corps, whereas that of Myslenice led to its flank or possibly even to its front. Consequently a big enemy push towards Kasina had to be anticipated and should be prevented by a counter-offensive movement. In view of that the following orders were given:

I. The 10th Horse Rifle Rgt., and A.T. platoon, a 10.5 cm. Howitzer troop (4 guns), an Engineers platoon—to remain at Peim, having as a mission the covering of the direction towards Myslenice and the holding of that locality until the end of the next day.

II. The rest of the Bde. forces, *i.e.*, 24th Lancers, a 75-mm. gun troop (4 guns), the rest of A.T. Squadron, the Reconnaissance Group, 2 Tank Coys., the A.A. battery and the rest of the Engineers Bn. should march by night through Myslenice to Dobczyce and from there southwards to the region of Kasina. At dawn a counter-stroke from that region was to be executed by 24th Lancers and 1st K.O.P., supported by all light tanks and 2 artillery troops, one of which belonged to the K.O.P. Rgt.

The execution of this manœuvre was rather difficult. It required 50, in some cases even 60, kilometres of night march to be accomplished before dawn. Myslenice was bombarded the whole night by the German long range artillery and the roads already began to be blocked. In spite of that, the Bde. reached in time the Kasina region where it met the K.O.P. Rgt., retreated there during the night. This Regiment, however, was tired and exhausted, not only by three days' fighting and marching but above all by the continuous fighting preparedness before the 1st of September; consequently, it had to be put into reserve as unfit for the purpose of immediate attack. The Reconnaissance Group was sent to Skrzydlno to protect the Bde. from the south-east direction.

Owing to all these changes our attack from Kasina on the 4th September started rather late, about 11 a.m., and met with a German attack led in the opposite direction. Nevertheless the enemy was surprised and the heights south-west of Kasina and north-east of Mszana Dolna were successively conquered. Two armoured cars and 3 light tanks were captured. Later in the day the enemy made two counter-attacks, the first repulsed with heavy enemy losses, and the second successful, throwing our forces back on the heights south-west of Kasina, where they contrived to maintain

obliged to reinforce that unit by directing to Szczyrzec the above-mentioned 2 squadrons of 24th Lancers which formed the Brigade's reserve.

About 5 p.m. both the general strategic situation and that on the Bde. sector became critical. The Army Corps failed to get disengaged from the enemy and was beating a retreat towards Bochnia pressed by overwhelming enemy forces supported by tanks. In the Bde. sector, the 12th Infantry Rgt. retreated towards north-east and the enemy's advanced columns occupied Myslenice, thus menacing the rear communications of the 10th Horse Rifle Rgt. which, at the same time, was itself attacked and pushed back. The 24th Lancers too were engaged and the Reconnaissance Unit was under menace of being outflanked from the east by a strong enemy tank formation.

In view of these developments the Bde. Commander decided to protect himself from the direction of Myslenice and not to allow the enemy to advance on Dobczyce before dusk. Two Bde. Tank Companies were ordered to march from Dobczyce through Zegartowice to Szczyrzec in order to reinforce the troops fighting there against the enemy's enveloping movement. The 24th Lancers were ordered to hold the heights near Wisniowa and, if forced, to retreat towards Dobczyce fighting back and retarding the enemy's advance. The A.A. Battery was placed north of the Raba bridge at Dobczyce, the guns levelled to A.T. fire. The 10th Horse Rifle Rgt. were to retreat towards Dobczyce.

Just after that "patching up" had been done, new orders arrived from the Army Corps to the effect that the Bde. had to regroup during the night within the region of Wisnicz Nowy and to carry on protecting the Army Corps' southern flank. Consequently all dispositions had to be changed to the following new ones:

(*a*) The 10th Horse Rifle Rgt. with 10.5 mm. Artillery troop to go to the region of Kopaliny (2 Km. north of Wisnicz Nowy),

(*b*) the 24th Lancers with 75 mm. Artillery troop to retreat through Lapanów to Leszczyny, which had to be defended.

(*c*) the Eastern Group to protect the march under (*b*) from the south. Two squadrons of the 24th Lancers belonging to that Group to join their Regiment after its passage,

(*d*) the Reconnaissance Group to go to Cichawka to protect the 24th Lancers from the north,

(*e*) the Tank Coy., the A.A. Battery, the Engineers, the A.T. guns (without detached platoons) to go to Wisnicz Stary and Nowy.

(*f*) Brigade H.Q.—Nowy Wisnicz, the school.

This complicated regrouping succeeded beyond all expectation. Bde. H.Q. reached Wisnicz Nowy late in the night and by 5 a.m. (the 6th September) liaisons with nearly all groups had been established.

We close our story at this point, which may be regarded as the end of the first part of the Brigade campaign when its mission was to defend the mountain defiles south of Kraków so as not to allow the enemy to pass the Myslenice-Dobczyce line. The Brigade accomplished its assigned task by holding that line against much stronger enemy forces until the 5th September.

* * * * *

The later fights of the Brigade were closely connected with the rapidly deteriorating general strategic situation resulting from the thrusts of the German Panzer Divisions combined with indiscriminate air bombing and fifth column activities. All this caused the progressive dislocation of our commanding centres and the break-down of liaisons and communications. Under these conditions the Brigade fought on the 6th September at Wisnicz, on the 7th north of Tarnów, on the 8th near Rzeszów, on the 9th and 10th on the San river, and, subsequently, until the 17th in the regions north-west and north of Lwów. On the 17th the Brigade was ordered to go to Halicz (on the Dniester river) as G.H.Q. reserve. On the same day, early in the morning, the Soviet mechanized troops invaded Poland. On the 18th

the positions at the price of considerable casualties. On the Pcim sector the enemy gained a few kilometres of terrain by throwing back the 10th Horse Rifle Rgt. on the Krzywica range about 5 Km. south of Myslenice.

The outcome of fighting on that day (4th September) must, on the whole, be called satisfactory. In spite of the attack led by 2 enemy divisions the Myslenice-Dobczyce line was not surrendered; there were even the prospects of our being able to hold it during the next day.

In the meantime the general strategic situation developed in an unfavourable way and the Army Corps which the Bde. now belonged to, had to disengage itself during the night 4th-5th September from the enemy and to execute a general retreat into the region of Bochnia. In accordance with the received orders (the contact had been established on the 4th September in the morning), the Bde. was to be reinforced by 2 further Infantry Rgts. and a Heavy Field Artillery Battery and, its force thus increased, was to carry on its task of protecting the Army Corps' southern flank. The prospect of these new reinforcements looked most promising but the reality was somewhat different. The Heavy Artillery Battery, horse drawn, was at about 100 Km. distance on the north of Vistula and could not possibly have been used by the Bde. on the next day. As for the infantry, it was, with exception of one battalion, overtired and not fit for immediate action. Under these circumstances the initially planned big counter-stroke could not possibly have been realized and the whole idea had to be abandoned. After some vacillations the following plan finally materialized:

Two of the newly attached battalions were to relieve the 24th Lancers and the 1st K.O.P. on their positions in Kasina-Mszana region, thus making these two Regiments free for the planned counter-offensive action.

Two tank companies were to go into reserve at Dobczyce.

The one infantry battalion of those newly attached which was in a good fighting condition and stood at Osieciany, should attack Pcim on the next day in the morning from the sector of the 10th Horse Rifle Rgt. The remaining new infantry, unfit for offensive action, had to cover the rear of the 10th Horse Rifle Rgt. by holding Myslenice against west and south.

The occupying of starting positions for the planned counter-stroke begun at dusk 4th-5th September, the infantry battalion from Osieciany marching towards Pcim.

On the 5th September early in the morning the first report from this battalion arrived. After having reached the outskirts of Raba valley it succeeded in surprising the Germans while preparing their own attack; it destroyed 18 of their motor-trucks and inflicted on them heavy casualties. The 10th Horse Rifle Rgt. upon hearing the sound of the battle, advanced frontally and conquered 4-5 Km. of terrain taking prisoners and some M.G. Only on the south of Pcim their attack was stopped.

On the Kasina-Mszana direction the enemy reconnaissance units displayed considerable activity during the night (4th-5th September). Anticipating an enemy attack and presuming that the relieving two battalions would not be able to arrive before the next afternoon, the O.C. Bde. ordered the main defence line to be organized south of Wisniowa, only contact troops to be left near Kasina. Two squadrons of the 24th Lancers on trucks, with one platoon of A.T. guns were to form the Bde. reserve at O.C.'s disposal with prospective mission of intervening on the eastern flank.

The enemy mistrusting our retreating movement acted very cautiously and did not start advancing before 4 p.m. after careful reconnaissance and artillery ranging.

About that time the 2 relieving infantry battalions reached their destination. They were, however, not very fit to relieve the 24th Lancers and the 1st K.O.P. at that dangerous moment and so the whole change had to be postponed for several hours.

In the meantime further unfavourable developments occurred. The Bde. Reconnaissance Unit at Skrzydlno was attacked by strong enemy forces and pushed towards the north. To counter the menace on his eastern flank, the Bde. Commander was

the Brigade received an order to cross the Hungarian frontier south of Stanislawów. They did it on the 19th, bringing with them all their field and A.A. guns, all heavy 20 mm. M.G's, as well as the major part of A.T. guns and other M.G's.

We may add that the Brigade, now in this Country under the same name, may be regarded as a genuine continuation of the old Polish Unit.

F.S.

THE INDIAN FORESTER.

(*February*, 1941.)—*Kanara Forests*, a talk to a Rotary Club by an Indian Forester, gives a succinct account of forest activities. Revenue and Expenditure figures given are interesting. In the past ten years, the former has amounted to a *karor* of rupees, the latter to Rs. 50 *lakhs*, a surplus of about £370,000. One is accustomed to look upon forests as providing timber only, but a list of by-products shows a much wider range—charcoal, bamboos, grasses for industrial purposes, leaf fodder, gums, resins, honey, wax, dyes and medicinal plants.

Dealing with an adjacent part of India is Mr. Dhareshwar's article on the *denuded condition of the minor forest in Kanara coastal tract*. Much of the denuded condition is due, in his opinion, to the habit, in pre-British times, of burning valuable forests, in order to clear out rebels and freebooters who had made of them a hiding place.

(*April*, 1941.)—*The semal* (Bombax Malabaricum) produces from the floss of its pods an excellent substitute for kapok. The tree is better known to the layman as "Flame of the Forest," so called from its vivid red flowers, which, coming out before the foliage, make a gorgeous display in the jungle, when it is otherwise at its most leafless stage.

(*May*, 1941.)—*The Early History of Indian Forests*. In legendary times and in the first stages of the historic era, India was very largely covered with more or less dense forests. Thus, an enormous tract between the Ganges and Jumna, and another in the north of the Punjab, were densely wooded. Most of these forests were destroyed by fire, bit by bit, to make room for cultivation and for other reasons, in spite of edicts going back as far as the Mauryan Empire (300 B.C.) proclaiming the penalty for anyone who set fire to a forest, "He shall be thrown alive into the same fire." Salutary regulations were made by Akbar, but these fell into desuetude with the decay of the Moghal power. It was not until the middle of last century that the British Government began the systematic control of forests.

The Editor notes that plywood identity discs are now being made for Indian troops.

From the *Control of Weeds*—an excerpt from the *Allahabad Farmer*—we learn that some weed seeds may remain dormant for as long as 30 years—a distressing fact for the amateur gardener.

F.C.M.

AN COSANTÓIR.

It should be corrected that *An Cosantoir* is a weekly and not a monthly publication. In No. 23, dated 30th May, 1941, Squad-Leader E. W. Healy, M.A., of Skibbereen Group, reviews the Local Defence Force at the end of its first year of existence. He recalls the fine enthusiasm with which the youth of Ireland came from farm, shop and factory, doubling in response to the original call to arms; "the glint of admiration in the eyes of those near and dear, the benediction of the old women from half-doorways." But the enthusiasm sobered. A spirit of laxity became evident in sparser attendances and dwindling interest, and an appeal is made by the author to his comrades to continue steadfast and firm and to remember that "the cynic, the grumbler and the scoffer are more dangerous criminals than the poor wretch that awaits the scaffold." "Duty, Service and Obedience" is their watchword. What they do, they do for Ireland, bearing proudly the history-rich title of Irish Volunteers.

F.E.G.S.

CORRESPONDENCE.

NOTES ON DEMOLITIONS, ETC., AFTER A RECENT AIR RAID.

To the Editor, *The Royal Engineers Journal.*

SIR,

I have had some experience of demolitions in a large town after heavy air attacks, and for those who have not had such experience, I hope you will allow me to add a footnote to the article by "Sap" in the *R.E. Journal* of June, 1941. It is that explosives should never be used in a town except where absolutely necessary, because they usually do damage to those neighbouring houses which are still habitable, and because they are also inclined to tickle up the unexploded land-mine which is being watched over with loving care by the experts. Experience has shown that a large proportion of all demolitions can be done by pulling, using fire escapes for fixing slings, steam-rollers, heavy lorries and bull-dozers; and that this method is often quicker than by using explosives. We have found that explosives are usually necessary only for high factory walls with no windows through which slings can be placed, a few very thick and solid corners of large buildings, and for some steel-framed houses.

I am, Sir, etc.,

J. ALDOUS, *Lieut. Colonel, R.E.*