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CONTENTS.

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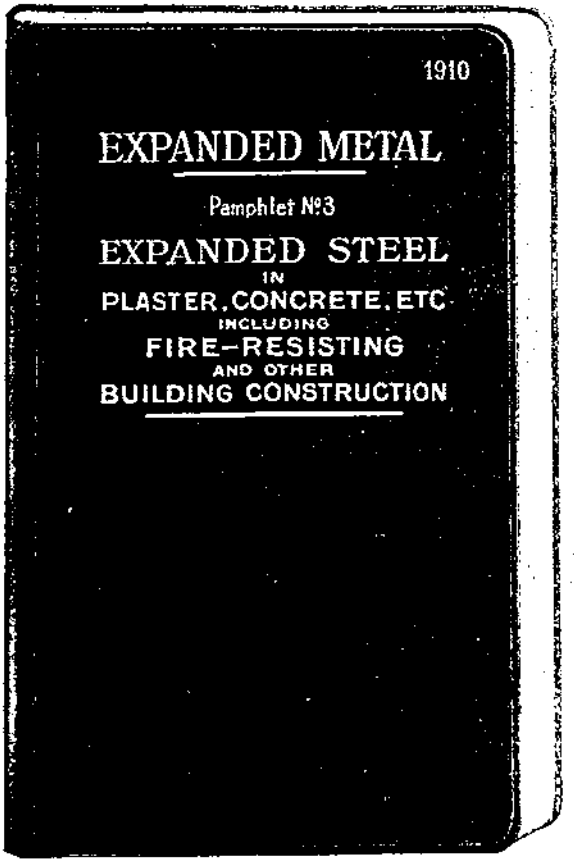

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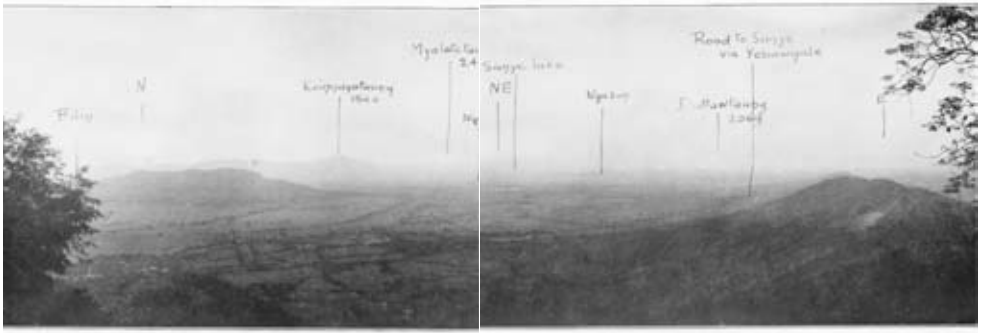


Photo No. 1.—View from Top of Kyaukse Hill.

Photo No. 2.—Bungalow and Camping Ground.

BURMA

ENGINEER RECONNAISSANCE IN UPPER BURMA.

By D.F.

LIEUT.-COLONEL SKEY in his interesting article in the *R.E. Journal* for November, 1908, suggested the practice in peace time of Engineer reconnaissances. Several such had already been undertaken in the neighbourhood of Mandalay by small parties of No. 15 (Burma) Company, 2nd "Q.O." Sappers and Miners, and it is thought that some account of these may be of interest.

Mandalay lies on the left bank of the River Irrawaddy in a plain varying from 12 to 20 miles in width between that river and the Shan Mountains. This plain is irrigated and mostly under rice cultivation: the western slopes of the Shan Hills which rise to 4,000′ and 5,000′ are steep and covered with dense jungle but on top is an inhabited plateau cultivated to a certain extent. The main railway line to Rangoon runs due south from Mandalay while to the east the Northern Shan States line to Maymyo, on the tableland referred to above, is continued to Lashio 100 miles from the Chinese frontier. Roughly parallel to this railway at distances varying from 4 to 30 miles flows the Myitngé, or Namtu, which joins the Irrawaddy at Ava 10 miles south of Mandalay, and with its tributaries governs the configuration of the mountain masses above mentioned.

These reconnaissances were usually carried out by a couple of officers, British and Burman, and three or four N.C.O.'s with a few pack mules. Each was based on a general idea and in every case a definite task was assigned to the party. Thus one was carried out from September 21st to 24th, 1908, on the assumption that Mandalay and Maymyo were occupied by opposing forces and the special mission of the party was to report on a route leading from Madaya (a small town 15 miles north of Mandalay) up the hills to the east and into Maymyo from the north. Work necessary to render the path suitable for a brigade with pack transport was to be noted.

On all these tours the work was distributed by allotting in turn to the various members of the party projects for the design of bridges, swamp crossings, etc., to be worked out with hand sketches and table of tools and working parties. A printed form was used for this.

In the above case, from Madaya to the foot of the hills a

number of small bridges and two or three crossings over swamps were required. Regrading was found to be necessary in several places on the ascent, and on the plateau some small bridges were wanted. This reconnaissance was carried out in three days, the party returning from Maymyo by train on the fourth day.

The object of another tour was to reconnoitre a route from Maymyo to the Myitngé River 20 miles to the south, and thence proceed by boat to the railway bridge by which the main line to Rangoon crosses that river, and prepare a project for its demolition with a view to cutting the communications of an enemy supposed to be holding Mandalay. The river however was found to be in flood and only navigable by bamboo rafts which required three or four days to prepare: so the party returned to Maymyo the way they came.

On another occasion the general idea was that a force invading Burma from the north-east had reached Maymyo; and the party starting from Madaya was to cut the Maymyo-Lashio railway near Hsumhsai Station 20 miles east of Maymyo where the line crosses several streams; and the route followed was to be reported on with a view to future use.

The following is a more detailed account of a reconnaissance carried out in March, 1909. On this occasion photos were taken to illustrate the report, a 12″ × 10″ stand camera and a 12″ × 4″ Kodak Panoram being used for the purpose.

The object was to reconnoitre a route between Kyaukse, a town 24 miles south of Mandalay on the Rangoon line (see map) and Maymyo so as to establish communication between a force coming up to Kyaukse from Rangoon and another at Maymyo, Mandalay being supposed in the possession of an enemy. The best route appeared to be *viâ* the Sunye Lake connecting and the Myitngé Valley connecting at Kywetnapa with the Mandalay-Maymyo main road *vide* map; this would be screened for the most part from Mandalay by the hills between Belin and the Myalate-taung.

The party consisted of:—Capt. D. Forster, R.E., Serjt. T. Cooper, R.E. (photographer), Naik Maung Po Thai, Lance-Naik Maung Myat Bwin, 2 sappers, 2 muleteers and 6 mules.

On the 25th of March the party left Mandalay by the 2 p.m. train for Kyaukse whither the mules had already proceeded. The same afternoon a photo of the country to the north-east was taken from the top of Kyaukse Hill (*Photo* No. 1).

The next morning the party marched to Sunye 10 miles distant across a level plain mostly under rice cultivation. The only work that day beyond a report on the road consisted in the selection of a camping ground suitable for any force up to a brigade, and in working out arrangements for water supply from Sunye Lake.

Photos were taken showing camping ground and the direction of next day's march (*Photo* No. 2). From Sunye the route led round the north end of the lake and thence over a series of rocky hills covered for the most part with bamboo jungle (*Photo* 3); the

Photo No. 3.—Highest Point on Sunye—Hngetgyithaik Path.

highest col crossed was about 1,100' and distant 7 miles from Sunye: from there the path led down in 3½ miles to the valley of the Myitngé, a clear cool stream 80 yards wide. The party ferried over, swimming the mules, and halted at Hngetgyithaik, a hamlet on the opposite bank, and in the afternoon got out projects for a brigade camping ground and for a flying bridge over the Myitngé with approaches, landing stages, etc. (*Photo* No. 4).

On the 27th the party divided, some going down the river by country boat to Kyetnapa, and the others with the mules following the path along the right bank to the same place. Capt. Forster and a sapper ascended the Myalate-taung (which rises precipitously on the left bank of the Myitngé) with a view to reporting on its suitability as a signal station. Projects were got out for some minor bridging on the path and for a camping ground at Kyetnapa.

Next day the party marched to Tonbo, arranged for the demolition of road and railway bridges over the Nadaungchachaung,

HIGHEST POINT ON SUNYE

a stream a mile east of Tonbo Station, and returned to Mandalay by train.

The weather throughout had been hot and misty and, in consequence, the photos were not as clear as they might have been. The 12" × 10" camera was not of much use; the best photos from a military point of view being taken with the 12" × 4" Panoram. On this tour the marches were shorter than on previous occasions and all work was finished up and corrected the same day.

In all these reconnaissances the conditions were almost ideal, as the ground traversed was for the most part new to all concerned and many of the paths followed were little known or used by anybody. The interest was further enhanced by the variety of terrain met with, steep mountains and level plains, open tableland and jungle-covered valley, while minor details were not wanting such as lakes, rivers, streams, canals, roads and railways.

There is no doubt that all ranks may learn a good deal from such tours which are also very enjoyable, especially in a fascinating country like Upper Burma.

Photo No. 4.—R. Myitngé at Hngetgyithaik.—Proposed Site for Flying Bridge.

MYITNGE

THE EMPLOYMENT OF ROYAL ENGINEERS ON MANŒUVRES.

THE following extracts from the diaries of the R.E. officers engaged in the recent manœuvres, have been kindly communicated by the I. of R.E. Giving as they do, a good idea of the work now done by the Engineers in manœuvres they are sure to prove of great interest to readers of the *R.E. Journal.*

. . . .

EXTRACTS FROM DIARY OF C.R.E., 3RD DIVISION.

SECOND DAY.

September 7th.—General and Special Idea.—(Appendix 11).

Operation Orders by G.O.C. Red received at 7.30 p.m. on 6th September.—(Appendix 12).

8.15 a.m.—Reconnoitred position with G.O.C. Red who directed R.E. to clear ground on right flank over which he anticipated that he would have to deliver his counter-attack.

9.30 a.m.—Issued Operation Order No. 9.—(Appendix 13).

11.15 a.m.—The G.O.C. being anxious to obtain information regarding enemy in front of our right flank which he thought they might be turning, I offered to send a well-mounted officer to reconnoitre.

Issued Operation Order No. 10.—(Appendix 14).

11.50 a.m.—Issued Operation Order No. 11.—(Appendix 15).

12 noon.—Seeing the enemy appear in strength on the right of our position, and commence firing on our reserve in the hollow in rear of the centre of our position, I took the 2 companies to Racedown to construct fire trenches to cover retreat which appeared to be imminent. The position was about 2,000 yards from enemy and as they were already engaged with our reserve, and were being taken in flank by our local reserves from point 401, we should not have been seen digging. We could have partly constructed two fire trenches each 40 or 50 yards long with an excellent field of fire.

12.25 p.m.—"Cease Fire" sounded.

Day fine and cool. Lieut. —— acted as Adjutant.

THIRD DAY.

September 9th.—General and Special Ideas.

I went out as C.R.E. Red Force. Lieut. —— acted as Adjutant.

56th Company Red. 57th Company Blue Force.

9.30 a.m.—Moved off from Hill Farm with G.O.C.

10.21 a.m.—Lieut. —— took down a copy of Operation Order No. 58, dictated by G.O.C.

10.25 a.m.—G.O.C. pointed out a position W. of the road opposite F. of Fontmell Wood which was to be entrenched by 56th Company, R.E., in case of failure of attack of right column.

10.40 a.m.—Pointed out site to Major ——.

10.55 a.m.—56th Company started to work.

11.10 a.m.—Showed Major —— Operation Order No. 58.—(Appendix 16).

11.11 a.m.—A Major, Royal Munster Fusiliers, came by order of G.O.C. to ask whether R.E. required any assistance from his battalion which was in reserve near cross roads N. of Sutton Hill. I asked for 1 company to prolong our trench to the left, and directed Major —— to point out site to O.C. Company on his arrival. I then returned to Headquarters of G.O.C.

11.50 a.m.—Attack being checked and counter-attack imminent, I was ordered to reconnoitre and entrench a position on right rear of trench now being constructed, so as to cover an eventual retirement from it.

12.20 p.m.—Selected and pointed out to Major —— site for a ½ company trench in a stubble field at W. of Fontmell Wood and directed other ½ company to prepare for defence the bank and hedge for 80 yards E. of cross roads at Hill Farm. Asked O.C. Royal Munster Fusiliers to send 1 company to help Major —— with the trench.

2.32 p.m.—Sent Lieut. —— to tell Major —— to retire as far as the wood at Sutton Hill road junction, as the evening's attack was now developing against our right column.

2.55 p.m.—"Cease Fire" sounded.

Notes.—Day fine and cool.

The necessity of infantry assistance in constructing fire trenches was clearly brought out.

FOURTH DAY.

September 10th.—General and Special Ideas.—(Appendix 18).

Operation Order No. 55 by G.O.C. Red.—(Appendix 19).

The above were received overnight.

12.40 p.m.—I took down Operation Order No. 59.—(Appendix 20).

12.45 p.m.—By direction of G.O.C. I issued Order No. 12.—(Appendix 21).

1.20 p.m.—Discovering that the 56th Company was already at Sutton Waldren, I sent in Order No. 13.—(Appendix 22).

1.30 p.m.—Sent extract from G.O.C.'s Operation Order 59 to O.C. 56th Company to explain my Order No. 12 and ordered Major —— to take command of the 2 companies and get his orders from G.O.C. 8th Brigade.

I gave necessary orders to the same effect verbally to O C. 57th Company and directed him to send an officer to Major —— for orders.

Both companies followed the attack carrying entrenching tools, leaving their carts in Sutton Waldren.

3.20 p.m.—"Cease Fire" sounded.

Notes.—Day fine and cool.

Adjutant, Lieut. ——.

APPENDIX 13.

Operation Order No. 9. *B. in British Settlement.*

O.'s C. 56th and 57th Companies.

Cut gaps in the hedges pointed out to you to facilitate the counter-attack.

Given verbally to O.'s C. 56th and 57th Companies at 9.30 a.m.

APPENDIX 14.

Operation Order No. 10. *Point* 401.

Proceed in the direction of Tarrant Hinton, pushing forward towards Tarrant Gunville and ascertain what you can of the movements of the enemy. Keep your orderly ¼ mile behind you to warn me if you are captured.

Given verbally to Lieut. ——, R.E., at 11.25 a.m.

APPENDIX 15.

Operation Order No. 11. *Point* 401.

Reassemble your companies at the spot pointed out to you and hold yourselves in readiness to accompany the counter-attack with your cutting tools.

Given verbally by Lieut. ——, R.E., to O.'s C. 56th and 57th Companies at 11.15 a.m.

APPENDIX 21.

Operation Order No. 12. *Point* 356 *W. of Sutton Waldren.*

O.C. 56th Company, R.E.

Both R.E. companies will assemble in field N.W. of farm at road junction just S. of Point 356 and be in readiness to follow the attack of centre column.

12.45 p.m.—By orderly to O.C. 57th Company. Verbally by Lieut. —— to O.C. 56th Company, R.E.

APPENDIX 22.

Operation Order No. 13. *Point* 356 *W. of Sutton Waldren.*

O.C. 56th Company, R.E.

Stay where this finds you, I will acquaint you shortly with the dispositions for the attack.

1.20 p.m.

EXTRACTS FROM DIARY OF C.R.E., 1ST DIVISION.

September 6th, 1910.—Joined Headquarters, 1st Division, at Bishop-Sutton Camp near New Alresford.

September 7th.—Marched to camp at Bossington Farm 1 mile S. of Houghton.

September 8th.—Received orders to reconnoitre River Test near Longstock House for position for pontoon bridge in case it should be required.

Report and sketch attached "A."

One copy given to G.S.O. in case I might not be with G.O.C. when required.

Left at 6.30 a.m. and rejoined 1st Division Headquarters at camp near Oldsarum at 4 p.m.

September 9th.—Left camp with G.O.C. at 2.30 a.m., reached Newfarm at 5 a.m. arrangements made for water supply.

Left Newfarm at 6 a.m. and went to left flank as directed by G.O.C. with Capt. ——as orderly officer, and 2 orderlies to reconnoitre near Cleave Hill near Longstock for approach of enemy's cavalry—about 8.30 had to retire on approach of enemy's patrols and rejoined G.O.C. at Upper Sandydown Farm 1 mile E. by N. of Stockbridge.

23rd (Field) Company prepared position at Woodbury Ring since its capture by A.G.

About 12.30 p.m. I ordered it to send ½ company to join 1st Brigade and other ½ company to join main body of 2nd Brigade.

I also ordered 26th (Field) Company to push on towards Sutton Scotney.

About 1 p.m. men of 1st Telegraph Company were ordered to repel sudden attack of enemy along Roman Road at Hill Farm.

About 2 p.m. I proposed to G.O.C. to push on to Sutton Scotney to reconnoitre defensive position for night outpost line E. and S. of village. Sketch attached "B." After reconnoitring Redhouse on E. was nearly captured about 3 p.m. After counter-attack had been made by 1st Brigade to N.E. about 5 p.m. G.O.C. reported cavalry was attacking from N. along Bullington Road.

I took out 26th Company already in position—½ 23rd Company and 1st Telegraph Company to repel the attack which was done successfully just before "Stand Fast" sounded.

September 10th.—Marched at 9.15 a.m. with G.O.C., about 10 a.m. I went to front to see if any work was required for attacking troops, found ½ 26th Company already at Micheldever Station repairing bridge which had been destroyed, 1½ hours to repair.

On arrival of ½ 23rd Company, I sent it to make level crossing at railway station which would take less time than repairing bridge and sent ½ 26th Company to join remainder which I had ordered forward to tunnel under main road. Pushed on to reconnoitre right front and ordered up 26th Company to defend West and Popham Farms with approval of Brigadier, 1st Brigade, who was just pushing forward attack towards Dunmer.

This would have been most useful in case of counter-attack on right flank. I then proceeded to left front, but found no employment for R.E. although 3rd Brigade had been checked since about 1 p.m.

September 12th.—On my suggestion a R.E. officer, Lieut. ——, was detailed as one of the five officers to reconnoitre the five roads to the front, leaving camp at 2.30 p.m. and in spite of several narrow escapes of being captured (his orderly was taken) carried out his duties. Report attached.

At 11 p.m. commenced night march—1 company being with the A.G. of each column.

September 13th.—Owing to the turning of enemy's left flank and rapid driving in of his troops by 1st Division no use was found for R.E. companies till "Stand Fast" sounded about 8.30 p.m.

REPORT ON PROPOSED PONTOON BRIDGE AT LONGSTOCK HOUSE.

(1). In order to protect construction of bridge, it would be necessary to first occupy wood "A."

(2). Wood E is out of bounds—but would form good starting point.

(3). There are 2 16′ punts at B and C capable of holding 6 men each. If no means of ferrying men could wade at B weir 2′ deep at C 3′ to 4′ hard bottom.

(4). (*a*). Bridge at C could be made from bridging equipment of 2 field companies.

(*b*). If approach is made through wood E, as it should be, it would take 1½ hours for 1 company to make approach road.

(*c*). If made at night after A is held, no approach road is necessary along hedge of E, but B is preferable.

(5). After position is occupied there is a fair road for artillery and wheeled traffic along cart track 100 yards N. of A and railway can be crossed with little labour if bridge is destroyed.

One ditch 15′ wide next to river could be filled with felled timber from E.

(6). The meadows on E. bank are generally heavy, and intersected with small drainage channels.

(7).—The bridge could be constructed by 1 field company in 1¼ hours by day, and 2 hours by night.

56TH COMPANY, R.E.

Extracts from Manœuvre Diary, 1910.

September 6th, 1910.—7.20 a.m. (Iwerne Minster).—Paraded and marched to rendezvous at Ralston.

8.40 a.m. (Ralston).—Received orders from C.R.E. to march with 1/K.R.R. to Hambledon Hill and to help place it in a state of defence. Marched to top of Hambledon Hill and prepared S. end of camp for defence. (Theoretical only). Vehicles to Child Okeford.

12 noon (Hambledon Hill).—Received orders from C.R.E. to send parties to prepare Hayward Bridge and bridge at Hammoon for demolition. Sent Lieut. —— to Hammoon and 2nd Lieut. —— to Hayward Bridge with Nos. 3 and 4 Squads.—(Attached).

12.5 p.m. (Hambledon Hill).—These parties moved off.

1.20 p.m. (Hambledon Hill).—Received orders from C.R.E. to move to road junction near P. of Fontmell Parva.

1.50 p.m. (Child Okeford).—Arrived at Child Okeford.

Ordered Lieut. —— with 1 and 2 Squads to march to road junction near Fontmell Parva *viâ* cross roads at first D. of Child Okeford. Rode to Hayward Bridge and found it prepared for demolition and party preparing to march to Fontmell Parva.

2.30 p.m. (Fontmell Parva).—Arrived.

3 p.m. (Fontmell Parva).—Marched back to camp.

4.15 p.m. (Iwerne Minster).—Arrived in camp.

5.30 p.m. (Iwerne Minster).—Paraded and marched to Pimperne.

7.30 p.m. (Pimperne).—Bivouacked for the night.

September 7th, 1910.—8 a.m. (Pimperne).—Paraded. Marched to defensive position near Langton Lodge.

8.40 a.m. (British Settlement).—Arrived.

9.14 a.m. (British Settlement).—Received orders from C.R.E. to proceed to near Point 401.

9.25 a.m. (300 yards N.E. of Point 401).—Arrived.

Employed on clearing hedges in line of probable advance of counter-attack. (Theoretical only).

11.15 a.m. (300 yards N.E. of Point 401).—Received orders from C.R.E. to proceed about 800 yards S.S.W. and prepare a line of defence facing S.W.

12.25 p.m. (800 yards N.E. of Point 401).—Just commencing to work when "Stand Fast" sounded.

12.30 p.m. (800 yards S.E. of Point 401).—Marched off.

2.55 p.m. (Iwerne Minster).—Arrived in camp.

September 12th, 1910.—6.30 p.m.—G.O.C. 9th Brigade arrived.

6.35 p.m.—Started with him to reconnoitre for bridge.

7 p.m. (R. Stour due S. of 2nd A. of Hayward Bridge).—This position approved by G.O.C. 9th Brigade.

7.15 p.m. (bivouac near Child Okeford).—O.C. Company issued orders for teams for pontoon wagons and for men to parade at once. Trestle wagon with civilian horses arrived.

7.20 p.m.—Marched.

8.45 p.m.—Arrived near site of bridge, having been delayed by transport of other units in Child Okeford, and commenced to unload bridging material off wagons and to carry it to river, a distance of about 350 yards, the wagons not being able to get nearer on account of marshy ground.

9 p.m.—Commenced construction of bridge, a party being detailed to continue carrying down material. Banks of river 6′ high. Gap 66′ in clear. 2 Weldon trestles and 2 pontoons used. Shore transoms sunk 2′ 6″ in banks, about 4′ 6″ from edge. Ramps made.

9.20 p.m.—Knocked off for teas.

10 p.m.—Resumed work.

10.30 p.m.—1 officer and 24 men of 1 K.R.R. arrived to make approach for transport over marshy ground.

12. m.n.—1 officer and 60 men of 1 K.R.R. arrived to dig ramps at each end of bridge.

September 13th, 1910.—1.50 a.m.—Bridge ready for infantry.

2 a.m.—9th Brigade commenced to cross.

2.40 a.m.—Infantry (3 battalions 9th and 2 battalions 8th Brigades) finished crossing.

4.15 a.m.—Bridge ready for artillery and transport.

5.45 a.m. (bivouac near Child Okeford).—Company arrived back in bivouac leaving 1 officer, 1 N.C.O. and 2 men at bridge.

57TH COMPANY, R.E.

Extracts from Manœuvre Diary, 1910.

September 9th.—5.30 a.m.—Breakfast.

6.15 a.m.—Marching order. Marched in rear of 8th Brigade, as part of Blue Force, taking 2 sections complete, and no bridging wagons. 56th Company were with "Red" Force.

6.55 a.m.—*Vide* Special Idea, attached, reached Point 784. I accompanied G.O.C. Blue to reconnoitre positions, arriving at Point 784 myself at 7.45 a.m.

By order of the G.O.C., entrenched 250 yards of position to command valley R. Range-Melbury Down. These trenches were for use of infantry if required. Selected site and ordered ½ company under Lieut. —— to entrench it.

8.55 a.m.—Ordered ¼ company under Lieut. —— to construct wire entanglements across col N. of Point 784. Lieut. —— plan was to collect poles from spars near site and to cut others from wood N. of Melbury Hill and to collect wire from neighbouring farms and send it up in farm carts. Calculated could have made belt 3 yards deep in 3 hours; but only 1¼ hours were available as enemy's scouts arrived 10.30. Considered the task was half done and better than nothing.

11.5 a.m.—Went to E. slopes of Melbury Hill and both ½ companies arrived there in face of enemy's strong attack. Had previously sent wagons to inn in Melbury Abbas. Now sent them by flag signal to cross roads N. of Melbury Hill to be safe.

12.10 p.m.—Reinforcements arrived, general advance on both flanks.

12.20 p.m.—Accompanied advance towards Point 784.

1.30 p.m.—Strong counter-attack on our extreme left. Occupied our trenches and helped to beat it off. Sent wagons, by flag signal to Compton Abbas.

1.50 p.m.—Continued advance, and now W. of Core Farm.

2.55 p.m.—Took part in assault on enemy's position W. of Fontmell Wood.

3 p.m.—"Cease Fire" sounded.

Company reached camp 4.10 p.m. Dinner on return. No casualties. Weather beautifully fine all day.

September 16th.—3 a.m.—Received orders to put Maperton and North Cheriton in state of defence, commencing 7 a.m.

4 a.m.—Reveille.

5.15 a.m.—Breakfast.

5.50 a.m.—Received instructions to move at once.

6.5 a.m.—Moved on North Cheriton, leaving 2nd Lieut. —— to take charge of pontoons and 2nd line transport. These ordered to park S. of Charlton Horethorne.

6.15 a.m.—Sent Lieuts. —— and —— to reconnoitre possibilities of defence of Maperton and North Cheriton respectively. Sent 2nd Lieut. —— with Lieut. ——.

6.50 a.m.—Reached North Cheriton. Left left-half company at Lieut. —— disposal, and advanced on Maperton.

7.10 a.m.—Arrived Maperton. Inspected Lieut. —— proposals for defence, and left him right-half company to proceed with the work.

7.50 a.m.—Back at North Cheriton. Lieut. —— gone as Adjutant to C.R.E. 2nd Lieut. —— in charge. Inspected his work and proposals. Work of defence now proceeding in both villages.

These villages form part of line of defence.

Operation Order No. 4 by G.O.C.

Note.—Weather fine but cold. Men had had no breakfast, as rations were not drawn last night.

Rations drawn in the morning at 6 a.m.

8.55 a.m.—Defence preparations of North Cheriton.

Left 2nd Lieut. —— in charge, went to Maperton.

9.15 a.m.—Found Lieut. —— preparations complete, left him and ½ company there and went to Maperton.

9.40 a.m.—Artillery duel opened.

9.45 a.m.—Returned to North Cheriton.

Found preparations complete and ½ company held in reserve by Colonel to aid in defence if required.

1.10 p.m.—Both ½ companies as before.

Received Operation Order 5, and C.R.E.'s Operation Order 1. I informed C.R.E. that I should remain as I was, unless I received further instructions.

2.30 p.m.—Strong attack by enemy. R.E. assist to repel it.

3.30 p.m.—Enemy assault. Attack judged to fail. We reoccupy our trenches.

3.50 p.m. "Cease Fire" sounded. The right-half company under Lieut. —— had gone forward to aid the attack of the 8th Brigade.

5.30 p.m.—Arrived bivouac at North Cadbury.

Put down pumps and troughs.

9 p.m.—Dinners. Breakfast rations extra.

Weather—fine and bright.

RESISTANCE AND "DRIFT" OF A BULLET.

By LIEUT.-COLONEL R. DE VILLAMIL, LATE R.E.

EVERY soldier, and more especially every Royal Engineer, must have thought about the resistance the air offers to a bullet, and must also have wondered why the bullet should be deflected to the right or left according as the rifling is right or left-handed. Textbooks state certain facts but do not appear to attempt to explain them. I thought therefore that a little light on the subject might not be unacceptable to the readers of the *Royal Engineers Journal.*

To take the resistance first: Professor Perry in his *Applied Mechanics* gives the facts as:—"Roughly we may take it that resistance is generally proportional to square of speed. In the case of shot this law holds, probably up to speeds of 300′ per second: from 400 to 1,000′ per second the resistance is possibly proportional to the $2\frac{1}{2}$ power of the speed. Beyond 1,100′ per second we may take, F being in pounds, d the diameter of a shot in feet, v the velocity in feet per second, $F = fd^2(v-800)$, where $f = 3$ for spherical and 2 for the elongated shot with ogee-shaped heads. The velocity is greater than that of sound, and probably it is to this that the change of law is due."

This statement of *facts* is exceedingly clear and precise, but explanation, of the why and the wherefore, there is none; a suggestion is indeed thrown out at the end that the sudden change of law at about 1,100′ per second is due to the velocity being in excess of that of sound. What is the law, however, which "changes" and why does it apparently change *twice?*

Professor Perry's statement that resistance is *generally* "proportional to square of speed" is not quite satisfying—more especially as he says later that a shot does not follow this law, except at very low velocity. Let us examine the subject more closely and see what is the true law of the resistance, and, if the law changes, *why it changes.*

Air is a compressible fluid. As this compression leads to complications it will be simpler to first examine the resistance in a non-compressible fluid, like water, and then, later, see how the elasticity modifies this result. A bullet, or a torpedo, moving in water meets with two forms of resistance, 1st that due to friction, and 2nd that due to the formation of eddies, or what is sometimes called "sinuous motion." These are the only two possible forms of resistance we can imagine.

Friction can only produce what is called "direct" (as opposed to sinuous) motion, and the resistance caused by it *varies as the velocity* only. Sinuous or eddy-forming resistance on the other hand *varies*

as the square of the velocity. The total resistance may therefore be expressed as :

$$R = AV + BV^2$$

where A and B are constants.

This law applies to *all* forms of liquid resistance. We see that (A being small) when V is not very great the resistance really does appear to vary, *very roughly,* as the square of the velocity. It is always *less* than the square in water, and it is generaliy given in textbooks as about the 1·83 power of the velocity.

Let us now turn to the elastic fluid air and see what complications arise. As the air is elastic the nose of the bullet compresses it somewhat and this adds a new resistance which does not exist in water. This resistance varies as the *cube of the velocity*, when our formula becomes

$$R = AV + BV^2 + CV^3.$$

As this statement may appear a little startling to some readers who have not thought of the subject, I must, necessarily, produce some evidence in support of it.

The molecules of air (or any other gas) to enable them to comply with Mariotte's law must be endowed with repulsive power which varies inversely as the *cube* of their distances apart. This was well known to the Chevalier Dubuat (Colonel of Engineers of France) more than 100 years ago, and is referred to in his *Hydrodynamique*, Vol. II. A very simple and elegant proof of this is also given in Bayma's *Molecular Mechanics*, which I quote in full, as this book is not well known.

"Let V be a cubic recipient containing n^3 molecules of gas, let d be the distance of the neighbouring molecules, p the pressure sustained by one face of the cube, ω the action of one molecule.

We shall have $V = n^3 d^3$, $p = n^2 \omega$.

Let V′ be another cubic recipient containing the same n^3 molecules, let d' be their distance, p' the pressure sustained by one face of the cube, ω' the action of one molecule : we shall have also

$$V' = n^3 d'^3,\ p' = n^2 \omega'.$$

By Mariotte's law we have

$$V : V' :: p' : p;$$

therefore

$$\omega : \omega' :: p : p' :: d'^3 : d^3$$

and consequently, *the actions of neighbouring molecules, within the limits in which Mariotte's law is applicable, are for the same substance inversely proportional to the cubes of the molecular distances.*

It will be obvious that the resistance caused by the bullet compressing the air must vary as the *cube of the velocity.*

It is clear that in the formula

$$R = AV + BV^2 + CV^3$$

the first factor AV will tend to *reduce* the resistance to less than the square; whilst CV^3 will tend to *increase* it beyond the square.

Between small limits the total resistance will vary *roughly*—not accurately—as the square of the velocity. There is no *change of law* at 300′ or 400′ per second, but as CV^3 increases more rapidly than AV the *total resistance* will increase, pass the square and eventually attain about the $2\frac{1}{2}$ power of the speed—as pointed out by Professor Perry.

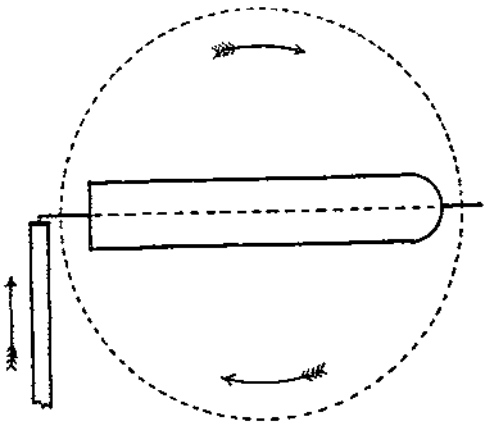
At about the velocity of 1,040′ per second (the velocity of sound) a *sudden* and abrupt change of the law takes place—more correctly, perhaps, "change of resistance," for the *law* is not changed. All the potential energy in the air being exhausted it is no longer capable of *increasing* its sinuous motion, which then becomes *constant;* when BV^2=constant. In the same manner the bullet cannot compress the air in front of it any more, so that CV^3 *also becomes constant.* The formula then becomes

$$R = AV + \text{constant}$$

or the resistance *increases as the velocity* only.

It is obvious that this is another form of Professor Perry's formula, where the resistance *increases as the velocity*—1,000 for each unit of increase of v.

Next, why does a bullet not travel in a vertical plane? Why does it "drift" to the right or left? Many years ago it was taught that the bullet "rolled" on the air. This was certainly not a convincing explanation, more especially as there appeared to be no special reason why the bullet should always select a horizontal plane of air to roll on. It is well known that a golf ball can be made to travel in a curved line (neglecting gravity, of course) and that it can even be caused to move in a curve *upwards*—against gravity. This was denied stoutly some years ago, although Newton was aware of it and gave an explanation. The explanation of the motion of the golf ball will not however apply to that of the bullet. The conditions are quite different and a shot cannot be caused to travel *upwards.*



For reasons which I cannot enter into very fully at present, the bullet is chiefly held up in the air by its rear end—by the vacuum formed there acting as a kind of sucker.

Imagine the bullet rapidly rotating and suspended like a gyrostat, as in the sketch. Since the effect of gravity tends to cause the bullet to rotate about a horizontal axis: and since the bullet is rotating rapidly, it will "precess," or move round a

vertical axis, which passes through the point of support. If the rotation of the bullet be right-handed the precession will be clockwise (looking down upon it) and if the reverse, then "counter-clockwise."

The solution is simple and interesting and has not, that I am aware of, been previously presented.

P.S.—It was only since writing the above that I became aware that Colonel Duchemin (? Eng. of France) published a book in 1842 stating that the resistance of a bullet might be expressed by the formula

$$R = av^2 + bv^3.$$

I have not been able to see this book—it is not in the libraries of the Royal Society, Royal Institution, R.E. Corps, Army Staff or British Museum—but my authority is A. F. Zahm, PH. D., in the *Philosophical Magazine* for 1901. Zahm conducted experiments on the resistance of bullets and examined the results by the use of Duchemin's formula when he says:—"The curve is steeper than the nearest one of the family $R = av^2$, and more nearly coincides with a curve of the family $R = av^3$; but more nearly still with a curve represented by the equation $R = av^2 + bv^3$, as manifested by Fig. 3, which is the exact graph of the equation

$$R = 0{\cdot}000008v^2 + 0{\cdot}00000049v^3."$$

"Thus the law of resistance so earnestly maintained, early in this century and controverted by nearly all later experimenters seems to be corroborated by the measurements made in this research, as far as they go."

This is a most striking confirmation of the formula given in my paper for Zahm's curve could equally be satisfied by

$$R = cv + \frac{1}{m}(0{\cdot}000008v^2 + 0{\cdot}00000049v^3)$$

when c is a constant and m a small number greater than unity: possibly the values of a and b might have to be altered *very slightly*.

The difference between Duchemin's treatment of the subject and mine appears to be that he plotted his results, and then found an empirical formula which would satisfy the curve; whilst I, on the contrary, started from theory and show that this must be the curve. Duchemin *does not appear* to have given any reasons why this should be the law of resistance—Zahm, certainly, gives none in his paper, either—whilst I have endeavoured to do so, and more especially as regards that part of the equation involving the *cube of the velocity*.

Duchemin's "remarkable book" is called *La loi de la Résistance de l'air sur les Projectiles*. He also published a paper in the *Mémorial de l'Artillerie* entitled *Recherches expérimentales sur les lois de la résistance des fluides* in 1842.

THE CORPS OF ENGINEERS IN NAPOLEON'S "GRANDE ARMÉE."

By Lt.-Col. G. M. W. Macdonogh, R.E.

Up to late years the student of the Napoleonic Wars has had some difficulty in ascertaining the exact composition and organization of the minor units that made up the French armies, and their methods of supply and command. The information was to be found in the Emperor's very voluminous correspondence, and in that of his marshals, but it was so scattered that much labour was required in order to collect it. The publications issued in recent years by the Historical Section of the French General Staff have gone far to remove these difficulties, and Capt. Lechartier's *Service de l'Arrière* issued a few months ago by that section will be found a veritable mine of information.

The advantages to be gained from the study of the Napoleonic campaigns would, it is thought, be much increased if the student were in possession of a clear idea of the resources that were at the disposal of the Emperor with which to carry out his designs, and it has occurred to the writer that it would be of interest to the readers of the *R.E. Journal* to have a slight sketch of the organization of the French Engineers during the Jena Campaign, when Napoleon reached the zenith of his career. In preparing this sketch full use has been made of Capt. Lechartier's book above referred to, and also of the Memoirs of Baron Fain, who was the Emperor's principal private secretary during the later years of his reign.

A short description is also given of the composition of a corps and of a division, as such a knowledge is necessary in order to understand the organization of the engineer troops.

During the Revolutionary Wars the largest tactical and administrative unit was the division which had an effective strength of about 14,000 men and was provided with troops of all arms. When, however, army corps were formed as permanent units (in 1803) the importance of the division declined and it became a subordinate tactical unit which could not operate alone. Napoleon in a letter to Prince Eugene dated Schoenbrünn, 7th June, 1809, indicated its powers by saying "that a division of 9,000 men can be left isolated without inconvenience for one hour, it will contain the enemy however numerous he may be and will give time to the army to arrive."

In November, 1806, the strength of the divisions varied from 6,000 to 8,000 men. Most of the infantry regiments had only two battalions present, with an average strength of 1,800 to 2,000 rifles. There was no divisional cavalry at all. The divisional artillery seldom consisted of more than 12 to 14 guns, and in one corps, that of Augereau, only 6 guns were left with each divisional commander, the remainder being taken to form an army corps reserve. There were no engineer troops nor tools with the divisions of any corps except the 7th, and the amount of transport both for supplies and ambulances was very restricted.

The normal composition of a corps was three infantry divisions, and a brigade of cavalry. The organization of the artillery varied not only in every corps, but also from day to day in individual corps. In 1805 the normal organization had been 12 guns with each division and an artillery park without guns with each corps. In 1806, however, corps artillery was to be found in many of the army corps. Some of the marshals adhered rigidly to the normal rule. Thus Lannes commenced the 1806 campaign with 12 guns allotted to each of his two divisions and none in reserve, and when in January, 1807, he was given 12 additional pieces he divided them equally between the divisions. Davout on the other hand had, on the 1st October, 1806, only 8 guns with each of his three divisions and kept 12 guns in reserve with the park. The guns captured from the Prussians at Jena and Auerstadt were either divided amongst the divisions or held in reserve at the discretion of the corps commanders. In some corps guns were attached to the light cavalry, for example Augereau formed a horse battery of two 8-pounders and one 6″ howitzer. The organization of the corps engineers will be treated at length later on, and the organization of the administrative services was so complicated that it cannot be dealt with here.

The composition of the Grande Armée itself varied at various periods of the 1806–7 campaign and is well known to the students of its different phases. It is only necessary to point out that Napoleon disposed of a reserve of artillery which was attached provisionally to the Guard Corps to Oudinot's Division and to the mobile artillery park. At Jena it amounted to about 30 guns.

We will now consider in detail the organization of the engineers. The Chief Engineer of the Grande Armée was General Chasseloup, who was assisted by General Kirgener, as Chief of the Staff, and by 7 to 10 engineer captains. Up to September, 1806, the engineer troops and tools were attached to the mobile artillery park, but before leaving for Saxony, Napoleon ordered the formation of a special engineer park composed of a detachment of miners, 1,000 sappers and 10 engineer officers, with carts carrying from 3,000 to 4,000 tools, which was to be organized in two parts. This park was actually formed on the 5th October, and was divided into two brigades

each about 800 strong. The 1st Brigade under General Cazals had a staff of 3 field officers and 5 captains, and consisted of 2 companies of miners, and 1 battalion and 2 companies of sappers. The 2nd Brigade under Colonel Dabadie possessed a staff of 1 field officer and 6 captains and was composed of 2 mining and 4 sapper companies; 4 more companies of the 4th Sapper Battalion were to be added to complete it.

By the 7th November the number of tools with the park had greatly increased and amounted to 15,000, consisting chiefly of entrenching tools, with a proportion of carpenters', joiners' and wheelwrights' tools. 24,000 tools were captured at Spandau, and 12,000 more were being sent up from Strassburg to Berlin, whilst 10,000 were retained at Würzburg, Kronach and Wittemberg as there was no transport available for them.

The bridging train formed no part of the engineer park, but moved with the mobile artillery park. It was commanded by Major Dessales, with a staff of 2 captains, and consisted of 7 pontoon companies with 18 officers, 569 men and 587 horses. On the 3rd November its material included 18 boats and 14 Prussian pontoons. In spite of the capture of the Prussian pontoons at Naumburg, the material of the bridging train was quite insufficient, so that when in December the army reached the Vistula, a river about 1,000 feet in width at this part of its course, it was detained nearly three weeks, as it was found impossible to throw bridges across the river suitable for the passage of the cavalry and artillery.

In each army corps, the engineers were commanded by a colonel, assisted by 1 major and from 2 to 4 captains. The colonel had directly under his orders the engineer park, which consisted of 1 or sometimes of 2 companies of sappers and a detachment of miners, with 5 or 6 tool wagons and 1 mining wagon per company.

The engineer officers, in addition to performing the ordinary technical duties of their corps, such as the construction of fieldworks, the repair and destruction of communications, and bridging, were engaged in many duties which would at present be left to officers of the General Staff. They were employed especially on reconnaissance work, in making sketches and road reports, in working out tactical problems, and in keeping the journal of the operations of the corps to which they were attached, with plans of the positions occupied, details of the actions, dispositions for attack and defence and a general criticism on all that had happened.

The engineer officers also assisted the topographical engineers, a description of whose work will be found later on, in making the maps, plans and sketches required by the Emperor and his marshals.

At the commencement of the Jena Campaign Napoleon devoted much attention to his engineers and ordered Berthier to see that plenty of entrenching tools were provided. On the 5th October,

1806, he wrote from Würzburg to Soult telling him to be careful that "3,000 to 5,000 entrenching tools always marched on a level with his divisions, so that a redoubt or simple trench could be made if circumstances required it."

The mining companies had each been provided with one tool wagon long previous to the opening of the campaign, but the sapper companies had not been so well supplied and were very badly equipped, getting merely whatever material was available in the army corps park. On the 1st October, 1806, however, Napoleon issued a decree from Mainz by which each sapper company was to be provided with one 4-horse wagon containing 500 tools. One similar tool wagon was allotted to each infantry division, and two or three to each army corps, which accordingly carried 1,000 to 1,500 tools. The special wagons which were ordered to be built for this purpose did not reach the army until the middle of 1807, and in the meanwhile the tools were carried in specially requisitioned vehicles.

In spite of these arrangements the army was as a whole very deficient in engineer troops and equipment. Augereau's Corps was the best supplied in this respect, as from the very commencement of the campaign it carried 1,000 entrenching tools packed in 12 wagons. It had also two sapper companies, one of which remained with the park, whilst the other was divided amongst the two divisions of the corps. In the remainder of the army there was only one or at most two engineer captains and no engineer troops with a division. These officers were attached to the divisional staff and were charged with all kinds of reconnaissance duties. They reported on the defence of villages and woods, and on how to block or defend defiles. They superintended the execution of all kinds of works and they were sometimes detailed to choose camping grounds, to prepare route reports, to reconnoitre bridges, obstacles, etc., and in fact, as is said in *Le Spectateur Militaire*, Vol. XIV., p. 393, to carry out all those staff duties which were classed as *fonctions savantes* as opposed to *fonctions militaires*.

Whenever a division had to execute fieldworks, the Marshal sent up engineers and tools from the corps park, and the engineer captain on the staff of the division took charge of the work, the regimental sappers, infantry working parties, and civil labourers being put at his disposal.

Davout's Corps was the only one which possessed its own bridging train. On the 29th September, 1806, orders were issued to the Commanding Engineer of this corps to organize a light bridge train consisting of two boats per division and two for the Headquarter Staff. The boats with their equipment were transported on requisitioned vehicles with the engineer park.

During the 18th and early part of the 19th century accurate maps were very rare and in many cases entirely wanting, the duties of the

topographical section of the General Staff were consequently very heavy. Under the Bourbons there had been a *corps des ingénieurs-géographes des camps et armées,* but it was abolished by a vote of the Constituent Assembly in 1791 on the motion of an engineer officer, Bureaux de Pusy. It was intended that the requisite topographical work in the field should be carried out by engineer officers in addition to their other duties, but it was soon found that this plan would not work satisfactorily and in 1793 the *Dépôt de la guerre* was re-formed and charged with the preparation of maps and plans. In the year XI. the corps of geographical engineers was again founded, with an establishment of 108 officers, under the command of General Sanson. During the Austerlitz Campaign it was known as the *Bureau historique et topographique,* but from 1806 onwards it was called simply the topographical service of the Grande Armée.

The work of this section was extremely hard. Its officers were employed in front of the army, and were frequently wounded or taken prisoner. Immediately after the Battle of Jena there were at General Headquarters 1 major-general (Sanson), 2 field officers and 9 first and second class engineers; and with each army corps there were 4 or 5 engineers.

The duties of the topographical service were three in number, viz.:—

(1). To mark every day on the general map the position of the army.

(2). Immediately after an action to make plans of positions that had been occupied and of the field of battle.

(3). To reconnoitre the country and the routes to be followed by the army, and this reconnaissance included the obtaining of statistical information regarding the resources of the country.

Napoleon demanded an immense amount of work from the topographical section, and at the commencement of the 1806 campaign its establishment seems to have been insufficient for the duties imposed upon it. Thus on the 2nd November the Emperor ordered Sanson to detail four officers to reconnoitre the Oder from Frankfort to the Baltic, together with the country lying for 3 leagues on either bank, on the supposition of a defence of that river supported by Stettin and Küstrin. Five days later he ordered four more officers to be sent to Posen to reconnoitre the environs of that town on the supposition that a battle would be fought there against the Russians, who were thought to be on the point of crossing the Vistula. The result of these orders was that Sanson was left with only one engineer-geographer under his orders at General Headquarters.

On the 2nd December, 1806, Berthier issued orders that in future all the engineer-geographers were to be directly under the command of

the *troisième aide-major général* (Sanson), who was to detach one of them with the advanced guard of each army corps for the purpose of making route reports, which were to be forwarded daily to Sanson for the Emperor's information. On the 1st May, 1807, the strength of the *personnel* of this section amounted to 1 major-general with his aide-de-camp, 2 heads of section, 13 first class engineers, 7 second class engineers and 10 third class engineers, or 34 officers in all, a strength which appears to have been sufficient to deal with the duties entrusted to it.

Napoleon attributed at all times the greatest importance to the topographical service. Wherever he was, it was his custom to allot one of his private apartments as a map room. This room contained a very large table on which to spread out maps and plans. At the Tuileries the map room lay immediately between the Emperor's bedroom and his study.

In 1806, Bacler d'Albe, who had been through the 1796 campaign in Italy as engineer-geographer to General Bonaparte, was appointed head of the Emperor's topographical bureau. His duties were to be present whenever the Emperor wished to read despatches with the map; he marked on the map with red and white pins the positions occupied by the troops, both friends and enemies; he coloured the maps so as to bring out the chief strategical features, and made any calculations of distance that were necessary.

As soon as the contents of despatches had been applied to the map in this manner, D'Albe made a short report to the Emperor, and Baron Fain (premier secrétaire du cabinet de l'Empereur) relates that the Emperor used to follow all the dispositions with his finger and measure the distances between the pins with a pair of compasses.

GIBRALTAR UNDER MOOR, SPANIARD, AND BRITON.

(Concluded).

By Col. E. R. Kenyon, R.E.

The Towers round the Coast.

During the 16th century Gibraltar in common with the rest of the coasts of the Mediterranean was harassed by the pirates whose chief, Barbarossa, was a terror to all the Christian coast lands. On 8th September, 1540, a force of some 2,000 of these Turkish pirates arrived off Gibraltar and disembarked before dawn the next day in the bays of Almadrabilla (north-east of Europa Point) and Laudero (now "Little Bay"). At dawn they moved forward in three parties, one against the Castle, a second towards the town, and a third in reserve and ready to collect and embark the spoil. They penetrated into the "Turba" ward before the alarm was raised; the Christians fled to the walled ward of the Barcina and the Castle; the pirates plundered the Franciscan Convent (now Government House), and then after some street fighting withdrew to re-embark with their plunder and captives, being joined on their way by the third party which had meanwhile sacked the hermitage of Europa. The whole re-embarked after being four hours on shore, with 70 prisoners, of whom only six were men. They then anchored at Puente Mayorga (Orange Grove) where they plundered vessels and houses, but not without loss as they encountered Spanish reinforcements which had come in from Jimena. Negotiations for ransoming the captives were ultimately brought to a satisfactory conclusion. It is satisfactory to note that the pirate squadron shortly afterwards fell in with that of the Spaniards under Don Bernardino de Mendoza and was completely destroyed with the loss of its two leaders, 800 Christian captives being liberated from the galleys, and 400 Turks being captured.* The raids on the Spanish coasts however continued, and as the fleet was insufficient to give adequate protection a series of 44 towers was built along the coast from the mouth of the Guadiaro to the Portuguese frontier at the end of Philip III.'s reign (about 1618).† Several of these towers still remain, such as those on the eastern shore known as the First and Second Towers, and the Rocadillo tower near the mouth of the Guadaranque. There was however an

* Montero, pp. 227—239.
† Ayala, p. 265.

earlier set of towers, some (if not all) of which were known as "Genoese." One of these stood above Laudero Bay and was occupied on the night of the pirate raid by two sentries who challenged the Turks, but ultimately had their suspicions lulled to rest by the answers they received, as narrated by Montero and Ayala. Another "Genoese" tower is mentioned in the Spanish Orders for the siege of 1727; and the same tower is no doubt referred to in the Remonstrance quoted in a former *Journal*, but the reason for describing these towers as Genoese is not known. Ayala (p. 33) in speaking of the one above Laudero Bay says "There was in this place a very ancient tower called that of the Genoese, without it being known why this name was given.* It may be conjectured that it was erected to correspond with another, which was outside the city, of almost identical construction on the summit of the Sierra Carbonera and that the Carthaginians or Romans had them made to warn Carteia of fleets approaching from the sea." The tower on the Carbonera, that of Cartagena and that at Martin Flores (Miraflores)† are mentioned in a document of November 18th, 1469, giving a list of the guards to be maintained and of their pay, which is printed as Appendix V. of Ayala. Montero in describing the ruins of Carteia says that the Rocadillo Tower, which is one of those mentioned above as built in the reign of Philip III., was probably erected upon the foundations of an older one, it being generally believed that the Carthaginians had introduced that method of watching the coasts. The history of the Devil's Tower is not known but its masonry is similar to that of the Sierra Carbonera Tower and it may, like the latter, have been one of the older series of "Genoese" towers.

It may be suggested that these Genoese towers may have been erected by Genoese workmen (perhaps early in the 16th century when Italian engineers were busily employed on fortifications under Charles V.) and that these workmen settled in the little cove now called "Catalan Bay," and that from them the name of "Genoese" came to be applied by the Spaniards both to the towers which they built and to the cove where they dwelt.

To the tower on the Sierra Carbonera the name of "Queen of Spain's Chair" has been attached, and to explain it an absurd legend has been so often told that it has been frequently believed to be true, to the effect that the Queen of Spain took up her position there during the great siege and said she would not move thence until she

* A "Genoese Tower" is marked on one of the plans of 1627 above Laudero Bay, but well inland, being shown as nearly due north of the Chapel of "Our Lady of Europa" (British Museum Add. MS. 15152). It seems highly probable that the ruins described by James and known as "The Inquisition" were the remains of this tower. These ruins no longer exist.

† Montero, p. 203.

saw the British flag lowered and that the Governor, in courtesy to her, allowed it to be hauled down for a few minutes; but that this is utterly without foundation is shown by the fact that we find the name used by Spilsbury and Drinkwater at the very beginning of the siege. On the other hand it is never used by James who left Gibraltar in 1755; and in one of his plans he gives a view which includes the Sierra Carbonera and marks the peak as "Mountains in Spain" whereas if the name of "Queen of Spain's Chair" had been then in use he would almost certainly have employed it. Thus it would seem that this name must have come into vogue between 1755 and 1779. An explanation of the name is given* in a Spanish book *Gibraltar y sus Alrededores* published in 1857 that some Spanish visitors were so charmed with the view from this spot that they said it would delight even the Queen herself to see it. The name is, however, not in use among Spaniards.

The name of Windmill Hill Flats is derived from the old mills which formerly stood a little to the east of the military prison (now Detention Barracks), but of which no trace remains. During the siege of 1779–83 General Eliott caused a new mill to be built on these flats, but on the night of March 21st–2nd, 1782, it was burnt down (Drinkwater and Spilsbury). Probably the ruined tower near the southern end of the flats is the remnant of this mill. The two ancient mills are shown on the 1745 plan in the Royal Engineer Office but only as two towers "formerly erected for windmills." In the time of Colonel James (1755) these flats were known as "Upper Europa."†

Some Names not previously Noticed.

Irishtown is the sole relic of an ancient custom which seems to have prevailed of naming districts after some prominent person or characteristic. For instance the following are to be met with in Garrison Orders and old journals:—Blacktown (G.O. of 30th June, 1787); Haynes's Town (G.O. of September 3rd, 1787); Hardytown (Drinkwater, 23rd May, 1781).

City Mill Lane is probably a corruption of Siete Vueltas (Seven Turnings, in allusion to its very winding nature). The name of City Mill Lane occurs in Garrison Orders of 20th January, 1780; but in those of 17th October, 1777, it appears as "Citamell Lane." The letters *v* and *m* being both labials may be interchanged without much difficulty. Another explanation which has been offered is that the name is a corruption of City Mall Lane, "Mall" being the old English word applied (as in Pall Mall) to places where certain games were played; but this idea hardly commends itself to those acquainted with the narrow sinuous lane and its neighbourhood.

* *Gibraltar Chronicle*, April 30th, 1909.
† Plan in James' *History*, Vol. II., p. 321.

The "*Black Hole*" or punishment cell for soldiers used to be at or near the site now occupied by the "Haven," the residence of the Colonial Treasurer who, it is to be hoped, finds it a more comfortable haven of rest than the former occupants of the site, who were under the care of the Main Guard which was where the Military Police Guard now is in Commercial Square, the old Grand Parade.* The "Black Hole" was the ordinary military name of such cells. For instance the notorious "Black Hole" of Calcutta, into which Surajah Dowlah crushed his unfortunate British prisoners, was the ordinary military punishment cell for a single soldier.

Arengo's Palace never was a "Palace," but was the residence of a Spanish family of that name, a member of which is nominated as Spanish Vice-Consul in a letter of 18th May, 1805, in a letter book at Government House (p. 169).

Buffadero Battery is perhaps an anglicized corruption derived from the Spanish "bufido" which means "blowing" or "snorting," a name which might have arisen from its wind-swept position; or it might be of Genoese origin, many Genoese workmen having been employed in Gibraltar. It is interesting to note that Buffavento is the name of a castle in Cyprus which was a favourite residence of the Lusignan queens.

Catalan Bay.—Whatever the origin of this name may have been, it certainly serves to keep alive the memory of the assistance rendered in the defence of Gibraltar by the Catalans after its capture in 1704. Montero, in his general description of the fortress as it was in 1704 (p. 276), says that this bay "was, and still is, called the Bay of the Catalans." This, however would appear to be a mistake, for the name does not seem to occur in any documents or plans earlier than 1745. When reference is made to that neighbourhood, as in the diaries of the siege of 1727, it is spoken of as the "back of the Rock" or "behind the Rock" and not under any specific name. It first appears on the plan dated 1745 in the R.E. Office, but as it, like all the other names on that plan, is written in ink it is possible, although not probable, that it might have been added at a later date. It appears also as "Catalan's Bay" in the print of a Perspective East View of the Rock which hangs in the Garrison Library and which was published in 1750. It therefore appears that the name came into use between 1727 and 1750 and probably before 1745. An explanation frequently given is that it was an English corruption of the word caleta ("a small bay") but as this name applied equally to all the other small bays round the Rock the explanation does not seem very probable, although some colour is given to it by a print in the Royal Engineer Mess, dated 1800, showing a view of "Catalan or Caletta Bay." A correspondent of the *Gibraltar*

* James, Vol. II., p. 350

*Chronicle** says that the *Diccionario Universal* published by Don Nicolas Serrano says that the bay is so called "because the inhabitants, a Genoese colony, follow the same trade of fishing as the Catalans"; and that no Catalans at any time lived there. It does indeed seem to be most probable that the name is really due to a confusion in the minds of the British garrison between the Genoese and Catalans. Both took an active share in defending the place. For instance in Garrison Orders of July 31st, 1720, the "Catalan Guard" is mentioned; on October 20th, 1726, "Catalainia" is mentioned in a list of the Guards; on July 4th, 1728, and on January 10th, 1729, "the Genoese Guard" is mentioned; and references to the Genoese are frequent in Orders and Journals. Of 22 surnames now in use at Catalan Bay 15 are of Genoese origin, 3 are Spanish, 3 are Austrian or Polish, and 1 is doubtful. Both Catalans and Genoese used to wear a peculiar red cap; both were foreign to the British garrison; both followed the pursuit of fishing; and both furnished guards to assist the English. The confusion between the two might therefore very easily arise; and this would be encouraged by the fact that the military authorities seem to have considered the Genoese and Spaniards resident in Gibraltar as people to be dealt with together. Thus in Garrison Orders of 24th July, 1720, it is directed that all "Spaniards and Genoese" able to bear arms are to be reviewed.

Some confirmation is given to this theory by the Spanish Orders for the siege of 1727† in which it is directed that "This day (February 22nd) is to be put into execution the opening of our works and batteries against the garrison from the Devil's Tower (now named S. Pedro) through the middle of the sands to the west strand; the parade of arms is to be established on the east strand near the Genoese Cove . . . the Lieutenant-General to be with the workmen . . . and to take up the ground from the first parade of arms to the tower of St. Peter . . . the Major-General is to take up the second parade of arms from the east strand to the Genoese Tower and to detach 2 officers with 30 men each to take up the ground from the Genoese Cove to defend the corner of the Rock in case of a sally from the garrison; . . . the Brigadier-General to run his trench from the Genoese Cove till he joins the situation of the first battery."

The Spanish Lines taken up in accordance with this order ran from the north-east corner of the Rock diagonally across the sands to the western beach. The "Genoese Cove" must refer to Catalan Bay, for there is no other cove in the neighbourhood. The cove being then known to the Spaniards by the name of its foreign inhabitants

* Father Jones, April 30th, 1909.
† James, Vol. II., p. 240.

it is easy to see how the British soldier would readily adopt the same nomenclature and, confounding Genoese with Catalans, and also hearing the place spoken of as a "caleta," would give it the name of "Catalan Bay."

The "*Europa Hotel*" or "*Hotel de l'Europe*" stood on the site now occupied by the southern end of the Admiralty workmen's buildings, or New Mole House. It was the scene of a grand farewell entertainment given to Prince Edward (afterwards Duke of Kent) on 11th May, 1791, prior to his departure for Quebec. The "ruins of an adjacent barrack" were fitted up for a ball and supper arranged by Capt. Fyers, R.E., as part of that entertainment.*

Mount Misery is a name now attached to a part of the crest of the Rock, but according to a MS. which appears to be of about the year 1767† the name originally applied to a work on the New Mole. Section III. of this MS. in describing the "new or south mole" says "It runs into the sea only about 110 yards in length. . . . The Mole batty or high Platform faced formerly towards the N.W. but there has been a new one made lately facing about S., mounting 10 guns by which it is greatly strengthened. In it is the Remains of a very high square wall once called Mount Misery because the Breaking down thereof was ordered as a Punishmt."

GIBRALTAR IN ITS TERRITORY.

Algeciras, Los Barrios, San Roque.

The town of Algeciras which faces Gibraltar from the western shore of the bay has seen many vicissitudes and has played a prominent part at various times in Spanish history. It was founded with materials obtained from the ruined Carteia‡ by the Moors almost immediately after their invasion of Spain under the name of Alghezyrah-Al-hadra or "The Green Island"§ which name in its Spanish translation is now applied to the small island (La Isla Verde) off Algeciras. "From 756 to 1031 Gibraltar lacked importance, being only a subordinate fortress of the Government of Algeciras which was then the strong and populous city, ruled by Royal princes, and the most important on the Spanish coast facing the Straits."‖

* *Life of the Duke of Kent*, pp. 27 and 28.

† Now in the possession of Major Harrison, Secretary, R.E. Institute.

‡ Montero, p. 52.

§ There is some doubt whether this name belonged in the first instance to the town, or whether it was not gradually confined to it after having been originally applied to the whole of Andalusia to which is given the name Al Gehzyrah (The Island) by Al Makkari who explains that lands washed by the sea on three sides were commonly called "islands."

‖ Montero, p. 94.

The remains of the Moorish aqueduct which supplied it with water are still to be seen in the neighbourhood, as well as some traces of the ancient wall of the town. "It is a singular fact that the only detailed notice of a Moorish hospital in the Peninsula is of that of Algeciras, which was founded in the 12th century. Tradition reports, however, that 50 public institutions of this kind existed at one time at Cordova."* In the year 1344 Algeciras was captured by King Alfonzo XI. after a siege of 20 months, in which he was assisted by Crusaders of many nations including a considerable English force, among whom were Edward III.'s grandson, the Earl of Derby, the Earl of Salisbury, and others. It is said that cannon were first used in Europe during this siege, the Moors making use of them in their defence. Two years later they were used by the English at Crecy. In 1370 Mahomed V. of Granada recaptured Algeciras during his war with Henry, the brother of Pedro the Cruel, after the latter had been murdered by the former with his own hand. Mahomed utterly destroyed the place†; and in December, 1462, King Henry IV. granted all its territory to Gibraltar,‡ which had been recovered from the Moors in August of that year. After the capture of Gibraltar in 1704 by the British, its Spanish inhabitants migrated and refounded the city of Algeciras, as well as founding those of San Roque and Los Barrios. The three combined were referred to in Royal despatches as "My city of Gibraltar resident in its territory" (campo), but San Roque was its head§ until 1756 when they were divided,‖ although the Governor of the whole continued to reside at San Roque until General Castaños moved to Algeciras, a change which received the approval of the Government in 1808.¶

Campamento, Jimena, and Castellar.

Other places in the neighbourhood also owe their rise to, or are connected with Gibraltar. Campamento, which lies on the outskirts of the ancient Carteia, was originated by the buildings constructed for Spanish troops in 1779.** Jimena was taken from the Moors in 1431, recaptured by them in 1454, and finally by the Spaniards in 1456.†† During the siege of 1779–83 factories for shell and cannon were established there.‡‡ In 1810 its castle was put into a state of defence by the guerilla General Ballesteros who was attacked there by a

* Scott, Vol. III., p. 516.
† Conde.
‡ Montero, p. 196.
§ *Ibid*, pp. 280—326.
‖ *Ibid*, p. 331.
¶ *Ibid*, p. 382.
** *Ibid*, p. 339.
†† *Ibid*, p. 392.
‡‡ *Ibid*, p. 340.

detachment sent against him by Soult.* Ballesteros deceived the enemy by a pretended flight and then fell on him and routed him with a loss of 600 among the crags between the River Hosgarganta and San Roque. Soult furious at this defeat, sent Oudinot with 10,000 men against him, but Ballesteros eluded him and took refuge under the guns of Gibraltar.

Castellar, like Jimena and Ronda, was one of the fortified posts on the frontier of the Moorish Kingdom of Granada and was consequently, like them, frequently the scene of battle. It was taken from the Moors in 1434 by the Alcaide of Jimena, and like that place was again taken and retaken. An interesting anecdote illustrative of the manners of the times, as well as of the nature of much of the fighting, is told of a combat in the woods of Almoraima. Washington Irvine tells it in his *Conquest of Granada;* and the following is a translation of Montero's narrative (pp. 210, etc.). Muley Hassan, King of Granada, "with an army of 1,500 horses and 6,000 foot passed by Marbella and Estepona and following the sea shore entered the territory of Gibraltar. Leaving this place on his left hand . . . and detaching 400 men to observe it . . . he sent 200 to raid the lands of Tarifa and a similar force into those of Medina Sidonia . . . Pedro de Vargas (Governor of Gibraltar) marched by night with 70 horse to Castellar, by which place Muley would have to pass on his return. On arriving there he had beacons lighted to alarm the country and sent messengers to Jimena and Alcalá calling for help. Muley realizing from the beacons that the alarm had been given hastily marched for his own frontier carrying his booty with him. He sent an advance guard of 300 horse . . . who were surprised in the Almoraima Woods by Pedro de Vargas . . . who retreated to Castellar with a part of the recovered herds. Muley followed with his main body, and pursued the Christians to the gates of Castellar and set fire to the houses outside the walls. There he halted, collected the herds which had scattered among the hills, and ordered that they should defile in full view of Vargas and his troops. To close the adventure he sent one of his officers with twelve of the best cattle as a present to Vargas, saying that he did not wish to deprive of his rights so valiant an Alcaide whose activity in collecting his dues had been apparent on this occasion. This proceeding pleased the Alcaide who replied in the same humorous style thanking him for the payment which he had made and expressing his sorrow that his scanty forces had not permitted him to receive him with greater pomp at his entrance into the district, but that he was expecting 300 horsemen that night from Xerez and that if they arrived he would attend on him at dawn with them. With this message he sent a rich cloak as a gift. Muley heedful of the warning and fearing the riders

* Montero, p. 384.

of Xerez pushed on his march through those rough mountains so precipitately that he abandoned more than 5,000 head of cattle which were recovered by the Christians, returning to Malaga with the rest of his spoil well satisfied with his expedition." * The name *Almoraima* is a Moorish word meaning "payment of fines,"† and perhaps owes its origin to the fines of cattle which were exacted by the Governor of Castellar from all herds passing through his territory, to which Muley Hassan referred in his message to Pedro de Vargas.

Carteia (*see Montero, pp.* 52, *etc.*).

Carteia was a Phœnician colony and is stated by Strabo (Book III.) to have been founded by Hercules.‡ Montero derives its name from Melkarth, the god of Tyre, and places its foundation at about 1,000 B.C. It was stormed by Hannibal in 220 B.C. but revived again as the Roman city of Tartessus, a name which was applied not only to it but to the whole of the south-western corner of Spain from Gibraltar to Cadiz. By many it is believed that this name is identical with the Tarshis of Scripture§ to which the fleets of Solomon cruised. Hither fled Cnœus Pompey after his defeat by Julius Cæsar at Munda (B.C. 45) which was in the vicinity of Ronda, and from its water gate he escaped, though captured shortly afterwards and executed. Coins prove that the city still existed in the time of the Emperor Honorius (395—423 A.D.) in whose reign Rome was sacked by Alaric, King of the Visigoths; but it is probable that it was destroyed about this time by the Vandals who overran Spain A.D. 410—425 and who left their name to Andalusia. Nothing now remains of the city except some massive fragments on one of its hills of what appears to have been a great square keep or citadel and the ruins of its docks which may still be clearly traced at low water, but it must have extended from Punta Mala to the River Guadarranque. Its ruins furnished materials from which Algeciras and Gibraltar were built and also San Roque when the inhabitants of Gibraltar settled there after their exodus in 1704. In 1845 the remains of buildings were discovered and statues, coins, and other articles were dug up between Puente Mayorga (Orange Grove) and Campamento. Among these were many large jars (amphoræ) with pointed bases, two of which are in the Gibraltar Garrison Library. They appear to have been funereal urns, as they contained ashes and calcined bones. It is

* Montero, pp. 210—212, on the authority of Alonso de Pal, Book 28, Chapter 3).

† Montero, p. 203.

‡ It is nearly certain that all references and traditions relating to a town at Gibraltar prior to the Moorish capture in 711 really relate to Carteia.

§ Smith's *Classical Dictionary*.

said that the city was supplied with water by an aqueduct of which remains may still be traced in the neighbourhood of San Roque,* consisting of a long underground channel on the western edge of the almond grove and some masonry fragments in a small vineyard a little further to the north. This channel is in very good preservation. It is built of stone and is about 5′ in depth when cleared of the earth which has accumulated in the interior. If however this aqueduct conveyed water to Carteia it can only have done so to the lower parts of the town or to gardens and fields in the surrounding valleys since it lies about 150′ below the level of the ruins of the citadel. This citadel, or keep (now known as "El Castellon"), is a square of 40 yards side with a wall 2′ thick and the ruins of three turrets at three of its angles. The north-west corner has no turret. The two facing eastwards were small in size, but that at the south-west was a massive structure measuring 24′ × 18′ internally with a brick vault below which may have been a tank or store. This turret commanded a magnificent view of the surrounding country especially towards the river and bay, and no doubt it was the principal watch tower of the place. It was the first Spanish fortress seized by the Moors after their disembarkation in the bay, and was known by the name of the Tower of Cartagena.

Hunting with the Calpe Hounds.

No account of Gibraltar can be complete without some reference to the "Royal Calpe Hunt" but it may be more interesting to "see ourselves as ithers see us" than to look at the excellent sport enjoyed with this pack through English glasses.

The following account is therefore extracted from the translation of an article which appeared in a Vienna paper *The Sport*. The author was an Austrian cavalry officer who joined the Mexican Foreign Legion and who spent a few days at Gibraltar with his regiment of Lancers on their way out in December, 1864, on board the *Peruvian*. The translation appeared in the *Chronicle* of February 14th, 1865. The meet was at San Roque. "The party consisted of 93 gentlemen and 5 ladies. No one of us would have thought it possible to hunt over a ground of this nature. It is a sign of the strongest passion for the noble sport to hunt in a country which is even on foot very difficult to pass over. It is almost impossible to describe the difficulties to anyone who has not seen them himself. These hills are only to be compared to the Austrian Karst Mountains, whilst at Gibraltar there are still more loose stones, the heights are even more precipitous, the water courses and ravines

* Montero, p. 70.

even rougher and deeper. Besides, the stony ground is almost entirely covered with brushwood 2′ or 3′ in height which hides holes and pieces of rock. Over these hidden obstacles even the most sure-footed horse is liable to fall. Who would believe that there, where one might expect only chamois to climb, one should meet a whole hunting field, not only consisting of gentlemen but even of ladies galloping with the greatest temerity down the hills? It was really frightful for us, unaccustomed to such daring feats, to see the most fair and lovely apparitions in the shape of English ladies in such evident peril. Our hearts were beating anxiously seeing them suspended over precipices where a moment of hesitation or the false step of a horse would have been sufficient to dash rider and horse to pieces. But the keen eye and the steady behaviour which distinguished them throughout assured us that they easily and surely surmount those dangers. All appeared perfectly at home on their horses and rode them with perfect ease and grace. . . . First we found a fox in the Pine Wood and ran him to ground. After this we came to some ground torn by furrows and chasms and without any wood. This ground and its difficulties for hunting defy description, and in vain do I look for words to express my astonishment at the courage and intrepidity of the English gentlemen and ladies. Only those who have learnt to ride in the 'Central Cavalerie Schule' over the Austrian Hochgebirge, will have an idea of the demands which riders and horses have to answer. We soon found another fox and then followed several very exciting runs. We rode without stopping over rocks almost as steep as a roof and through streams of water. Unfortunately they did not kill as they had so well deserved." The present Master is Don Pablo Larios to whom the garrison of the Rock owes everlasting gratitude for the sport which he and his family have done so much to maintain.

Rainfall.

Life at Gibraltar is so greatly affected by the rain that this article may fitly be closed with a few of the more important facts about the rainfall which has been regularly recorded from the year 1790. Its average amount per annum up to 1908 inclusive has been 33·12″ but its variation is very great. During this period it has varied from 15·12″ in 1800–01 to 77·14″ in 1855–6. Seven times the fall has been less than 18″ and 12 times it has exceeded 50″. The highest recorded fall in any one day during this period was on 14th December, 1796, when 9·13″ fell; but in the *Encyclopædia Britannica* (Vol. XVI., p. 150) it is stated that on one occasion (the date of which is not given) 33″ fell in 26 hours. Possibly this was on 30th January, 1766, on which day Ayala (p. 365) records a tremendous fall of rain which blocked the streets with *débris* and drowned 50 people. Colonel

Skinner states that it destroyed 130′ of the Line Wall at Rosia.* Falls of from 4 to 6″ in one day are recorded fairly often, and it may therefore be easily understood that the rivers and streams in the neighbourhood vary greatly in depth and that the fords are constantly changing. An accident which occurred on 13th December, 1864, illustrates this danger. Ordinarily there is no difficulty in fording the mouth of the river at Puente Mayorga (Orange Grove) but after heavy rains it is sometimes impassable. On that day an Irish car with four officers in it, a driver and a postilion was carried away by the current at that spot and upset. All were drowned except one officer.†

* An extract from a report by Major-General Irwin dated February 3rd, 1766, is published in the *Annual Register* for 1766 (p. 74), from which it is seen that it was a violent thunderstorm with heavy showers of hail. "Between 8 and 9 at night the whole hill and town seemed to be on fire, and spouts of water poured down from the clouds. . . . In a few minutes the ground floors of all the houses in the town were full of water, the hail and rubbish having stopped up the drains. . . . Almost everybody in the town has suffered. It is scarcely possible to describe the melancholy scene of parts of houses, furniture, men, women, children, and animals of all sorts floating in the water, or stuck in the rubbish; and do suppose that since the misfortune at Lisbon, so dreadful an accident hath not happened to any town; nor could anything more resemble that than this, many of the streets being entirely choked up with the rubbish, and the inhabitants obliged to come out at their upper windows, and some to break their way through the tops of their houses."

† *Gibraltar Chronicle.*

MODERN FIRE APPLIANCES.

A SURVEY OF PROGRESS.

By CAPT. E. H. HARVEY, LATE R.E.

THE rapid development of and improvements in modern apparatus and organizations for saving life and property from fire, have been already alluded to in previous papers which I have contributed to the *R.E. Journal*, and, now that to a great extent these innovations in the shape of motor and other special appliances have undergone the test of service, it may not be without interest to engineers to add a few further notes on the subject. R.E. officers have at times to consider questions of the public service of towns and districts outside their immediate barrack and military duties, and it is hoped therefore that the information here given may be of some use, as a record of what has been done in municipal and public work for efficient fire protection up to the present date.

Improvements in Life-Saving Apparatus.—It is noteworthy that, up till about 13 years ago, no very great departure had been made in English fire-brigade practice from the standard machines and methods in use since the introduction of the steam fire engine in the "sixties," and of the telescopic fire escape. Improvements in detail—in quick-steaming boilers—and in reducing the weight of apparatus, etc., had, of course, been in progress; but no very marked improvement in the means for life saving was generally brought forward until about 1897, when the introduction of the horse-drawn fire escape in London showed the first important advance in modern methods.

The old system of hand-drawn escapes stationed in the streets, and each manned by a couple of firemen detached like "outposts" from the district fire station, had the disadvantages of dispersing the strength of the available *personnel*, and of exhausting the men with the labour of hauling their machine to the scene of action, before they could even commence their work of rescue, and the now well-known horsed escape, bringing a fully manned crew fresh from their quarters and ready for vigorous action, has proved to be one of the greatest benefits to the public service that has yet been introduced, though light hand escapes stationed at suitable points are sometimes a valuable auxiliary in many towns being worked by the police as well as by firemen.

Adoption of the Chemical Engine.—Not long after this improved appliance had been brought into extended use in London and the

provinces, an addition of great utility suggested itself in the form of the "Chemical Engine" which had long previously been in vogue in America. The cylinder containing—in the various sizes—a supply of from 35 to 60 gallons of water, was found capable of convenient attachment transversely (usually under the driver's seat) to the carriage of the escape, and at the time of the Fire Exhibition of 1903 at Earl's Court, a combined machine of this pattern was exhibited, having a small-bore hose coiled up ready for immediate use with the chemical cylinder in a cage, which permitted of its being run out with the utmost rapidity immediately on arrival at the scene of work. This was in addition, of course, to the supply of full-sized hose, standpipes, branchpipes, etc., for work with the street hydrants or ordinary fire engines.

"First Turn-Out" Machines.—This form of appliance—combining in itself "first-aid" engine and escape with hose—has since been adapted to motor propulsion with success, and in most up-to-date fire brigades is the machine that is generally found to be most suitable for the "first turn out" on receipt of a call. The experience of the London authorities alone, since its adoption, has amply proved its value in the saving of many lives and much property. The chemical engine, it may be remarked, is really a modern and scientific application of the principle, long adopted on the Continent, of turning out on the first call a small manual engine with hose-reel and a water-cart—enabling a small jet of water to be brought into action almost immediately on arrival at a fire, while, it may be, a long line of the larger hose is being laid down to the nearest available hydrant, or, in some cases, while a steam fire engine is delayed for a few moments in getting up its full working pressure.

The horsed or motor escape will usually be followed at once by a steamer, except in attending small fires in towns that have a constant high-water pressure on the mains, and a very complete hydrant system, when experience may show that the latter alone is sufficient to deal with ordinary outbreaks, the steamer being held in readiness and sent on on "second call." This system of working from hydrants alone, while economical, has its risks unless all calls are received in some detail by telephone (if not verbally), and great discretion and forethought are used in ordering the steamers out at once, on the first information received.

Special Uses of Chemical Engines.—The chemical engine has its special value in districts where hydrants are few and far apart, and on high levels in hilly places where the water pressure on the hydrants may not always be satisfactory during the first few moments after a fire has broken out: *i.e.* until the waterworks have time to increase it and make necessary arrangements. In selecting appliances for use on hilly roads it must, however, be remembered, that the weight of some 40 to 50 gallons of water in a strong metal tank with

special hose and other attachments, is a considerable addition to the total weight to be hauled, though in this particular a motor-driven machine would be little affected in comparison with one drawn by horses. Obviously, too, the machine should be stationed at a high level in the district where it is wanted, although many fire brigades have yet to put up with stations at low levels, and inconveniently placed.

A later modification of the "chemical engine" adopted by the London Fire Brigade several years ago, and since elsewhere, is the substitution of a cylinder of compressed air or compressed CO_2 for the acid bulb arrangement and chemical action as the motive power for the "first-aid" jet. This has the advantage that the whole of the water in the tank need not necessarily be ejected, should it not be all required for the extinction of a small fire—the tap admitting the gas or air being shut off whenever desired.

In motor steam fire engines a "first-aid" jet, through a small hose similar to that of a chemical engine, has more recently been provided for by fitting a small-sized auxiliary steam pump in addition to the main pumps, which takes its supply from one of the ordinary tanks on the engine until the main pumps or a hydrant be set to work. This arrangement is, of course, rendered practicable by the fact that the steam motor arrives at its work with full boiler pressure available.

Hook Ladders.—Reverting to the subject of life saving, increased attention has been drawn of recent years to the means of access to exceptionally high windows, or to those too high to be reached by scaling ladders or ordinary ladders which overlook gardens and other enclosed places inaccessible to an ordinary wheeled fire escape. The hook ladder—an adaptation in ladder form of the method of scaling a height by throwing up a light grapnel and climbing up the rope attached thereto—had been in use on the Continent and in America for many years (since the early part of the 19th century). In those countries it had been preferred to the wheeled escape, largely on account, in the former case, of the existence of narrow streets and courts too cramped for the working of the latter, and in America on account of the abnormal height of many buildings.

The pattern adopted largely in England is two-sided, with a single hook that folds down flat on the ladder for convenient stowage. This can be carried loose, in place of a "first-floor" ladder on the main ladder of the ordinary fire escape, and is used either from the top of the latter for reaching exceptional heights, or in such enclosed places as I have mentioned.

It may also, with its hook folded down, be used as an ordinary light, short ladder, and is, in skilled hands, a useful auxiliary appliance. The head of the ladder is made to rise a short distance above the position of the hook, so that it affords the fireman some hand hold when starting to descend—an important point.

It is obvious that ordinary untrained persons cannot make use of these hook or "Pompier" ladders, and therefore, wherever practicable, the ordinary telescopic escape is the more convenient appliance, and enables a "rescue" operation at a fire to be carried out more easily. A canvas shoot may of course be used in conjunction with the "Pompier" ladder in some cases—being drawn up by the firemen after they have scaled the required height, and taken up a firm position—but, on the whole, "Pompier" ladder work is more or less risky, and requires good training and selected men to get the best results.

Very useful light telescopic ladders reaching to a height, when extended, of some 35′, and specially braced for strength and stiffness, are now made for use in enclosed gardens, etc., being carried overhead in some first-aid machines, in preference to the larger wheeled escape. These are very suitable to residential districts where there are many villas of moderate height surrounded by garden walls. With the addition of one or two lengths of hook ladder and a skilled detachment of firemen, the equipment will meet most cases likely to occur in such localities.

Introduction of Steam Fire Engines.—The steam fire engine, though its general adoption in public fire-brigade work did not commence till the early "sixties," is an invention of earlier date than is often remembered. I am indebted for the dates mentioned below to Mr. Young's exhaustive historical work on "Fires, Fire Engines, and Fire Brigades," which gives a complete account of the subject up to the date of its publication some years ago. It may be of interest to note that as far back as 1829, Messrs. Braithwaite and Ericsson built a serviceable horse-drawn "steamer," burning coke and having a boiler similar to their "Novelty" locomotive which competed with Stephenson's "Rocket." This engine, though slow in raising steam in comparison with its modern successors, did good work, but it seems to have been in advance of its time in Great Britain and was not adopted by the fire authorities in London, (possibly owing to indifferent water supply in the streets) in spite of its success. Engines of this type, however, were made for Liverpool and Berlin, and appear to have given satisfaction.

In America a self-propelling steam fire engine was built as early as 1840 in New York, and another in Cincinnati in 1853, and in the "fifties" the steamer was coming into use in various American cities, including Baltimore and Richmond, Va. (1859). The first land steamer was used in the London Fire Brigade, (then called the "London Fire-Engine Establishment"), in 1860, and from that time its introduction gradually spread at home and abroad.

Motor Engines: Their Advantages.—About the year 1900, Messrs. Merryweather produced the successful self-propelling steamer known as the "Fire King." This has had universal success in many

countries, and is still preferred by some authorities to the more recent petrol motor pump for long-continued heavy pumping jobs. The oil-fired steam motor engine has one great practical advantage in that on return to its station there is the minimum of trouble to the station staff, *i.e.* no boiler fire to rake out and re-lay ready for another call, (perhaps a "false alarm" an hour or two later in the night to be followed by the same trouble for nothing), and no horses to attend to—the oil fuel being shut off and the gas or other heater re-connected the engine is ready for duty again at once.

The petrol engine has, of course, similar advantages, and requires no heating to be maintained. All motor fire appliances, if fitted with suitable power, have the advantage over horsed machines that they can carry a strong crew of men without considering the overloading of horses on long or hilly journeys.

Modern Steam Fire Engines.—The ordinary patterns of steamer being still likely to remain in use for many years, and being also an appliance useful to Engineers for emergency pumping operations, such as camp water supply, waterworks breakdowns, etc., it may be of some use to give a short notice of the leading types.

Types of Engine.—The modern steam fire engine is, except in its smallest sizes, very generally of the double-cylinder vertical type; *i.e.* two steam cylinders and two pump cylinders vertically below them, with the pistons of each couple rigidly connected. An intermediate crank shaft to give motion to the eccentrics and slide valves and regulate the stroke is actuated either by "return" connecting rods or by slotted links. This vertical type, with the machinery placed at the back of the boiler, is exceedingly convenient for allowing access to the working parts. The horizontal type of engine, however, with the machinery fixed between the main frame of the carriage in front of the boiler, leaves the back of the latter absolutely clear for the work of stoking.

Stoking Arrangements.—Much discussion and difference of opinion has arisen about the relative merits of the rear or side position of the fire-box door, and of "rear stoking" as compared with "side stoking." Engines of the vertical type alluded to above, if the crank shaft is driven by connecting rods, naturally occupy rather more vertical space than if the slotted link action is employed; in the former the fire-box door is placed at the side of the boiler, and when the engine is stationed for work the fore carriage is locked round to give more room for the stoking operations. The inlets and outlets of the hose can be placed at a low level above the ground, and the stoker is out of the way of those attending to the machinery and connecting the hose. On the other hand, the fire cannot be stoked or attended to while the engine is travelling, and it is therefore very important that it be skilfully laid, and lighted up if not, as in short runs, at starting, at the right time on nearing

the scene of action. The lighting up may be accomplished, if desired, by a patent apparatus, and the fuel effectively kindled while travelling.

In a "rear-stoking" engine there is the facility for giving attention to the boiler fire while on the road, and the adoption of the slotted link action for turning the crank shaft, as in Messrs. Merryweather's "Gem" type, enables the machinery to be made compact enough for the fire-box door to be placed beneath it at the back of the boiler.

On the foregoing question it may be said that both classes of engine are in extensive and successful use, and that it is for intending purchasers to weigh their relative advantages.

Older Types.—Of earlier types of steamer now being supplanted by the modern ones alluded to above, two famous designs may be named. The first of these is Messrs. Shand and Mason's "Equilibrium," a vertical engine with three steam and three pump cylinders, the action of which is regulated by a crank shaft as in the "double vertical," with three cranks set at an angle of 120° with each other. Great power combined with steadiness of running is obtained in this type. The second, another most notable class which has done good service during the last 40 years, is Messrs. Merryweather's "Twistbar" machine; a horizontal slow-stroke engine without crank shaft or fly wheel, the steam valves being actuated by means of the partial rotation to and fro on its own axis of a twisted steel bar or shaft parallel with the piston rod and rotated by the forward and backward motion of a kind of claw attached to the latter. Very powerful engines of this class have also been made with double cylinders.

Hand-Drawn Steamers.—For the protection of small "risks" where, as in a factory, private residence or institution, only a limited area has to be traversed, small hand-drawn steamers of the "Valiant" and similar types are light and useful: they have, as a rule, a pumping capacity of from 100 to 200 gallons per minute, and may stand on their own base when at work—the carriage being detachable or be fitted on four wheels.

These very small steamers are sometimes mounted on a horsed carriage for the requirements of village and private brigades. Where an engine of this kind is mounted only on a "skeleton" hand carriage, it is important to provide a suitable handcart or truck to accompany the engine, and carry all the needful coal, hose, tools and small gear. These, otherwise, are liable to be mislaid or forgotten, especially in the dark, and some good lamps, it need hardly be said, are also essential.

Accessories.—Makers of fire engines supply with their machines a complete list of the accessories required for working. Among the most useful fittings may be named the "breeching"—or Y connection—enabling a line of hose to be divided into two, for supplying two jets from one hose, or for combining two streams into one

"branch" and nozzle. With steamers the friction in the hose can be greatly reduced in this latter manner, where the whole power of the engine may be required to be concentrated into one nozzle of large diameter for the purpose of throwing a specially high and heavy jet. Two lines of hose from the two delivery outlets fitted to an ordinary medium-sized engine are sometimes united in this way by a breeching, this method of working being termed "Siamesing." The power of two manual engines of similar capacity can in the same way be concentrated into one large nozzle for exceptional purposes, this mode of working having been a necessity in old days before steam power was available, when a specially heavy jet was required.

Water Towers.—Of other recent appliances much has been heard at times of the "water tower." In America these special appliances (necessary for dealing with exceptionally high buildings) consist of a horse-drawn carriage carrying what may be termed a "portable rising main," having a large nozzle capable of being raised to the level of the fire and directed from below by suitable gearing. The power of two or more engines is concentrated in the "tower" by separate hose inlets. A less elaborate arrangement, attached to the ordinary long fire escapes, has hitherto been found sufficient for the more moderate-sized buildings found in Great Britain.

High-Pressure Water Systems.—A special high-pressure hydrant system has lately been adopted in New York, and may be called a valuable auxiliary, but any underground water system involves the risks of a partial failure through unforeseen accident or bursts, and it is unlikely that portable fire engines will ever be dispensed with with safety. In any case large heavy vehicles will always be necessary to carry the firemen and hose to their work.

Value of Floating Engines.—In conclusion, brief mention may be made of the experiences deduced from the great fires that have followed recent disastrous earthquakes, of which not the least noticeable is the advisability of the provision, where practicable, of floating engines or "fire boats" which, unless some altogether abnormal upheaval of the sea bed takes place, will often be able through long lines of hose, to render valuable aid from the sea or river, after the ordinary water service of a city has been totally dislocated. Large, heavy land "steamers"—sometimes found obsolete for fast travelling—may similarly, if kept near the water side, form a useful reserve in case of disaster, owing to their great power and range of action uphill as well as on the level. The expenditure allowed for their upkeep may under such circumstances, be recovered many times over, by the value of the property saved from destruction.

Since the completion of the foregoing paper a Report of great interest dealing with recent progress in fire brigade work in Berlin,

Hamburg, and Hanover, has been published by the British Fire Prevention Committee as No. V. of their Journal. This also gives information on fire-resisting construction in warehouse and other buildings in the cities named, and contains a number of valuable diagrams and illustrations.

My previous remarks have chiefly referred to British fire appliances, and a few points in German practice as described in the above Report may be briefly alluded to, as showing a similar advance in matters of motor traction, etc. :—

(*a*). The adoption of large motor chemical (or CO_2) engines, taking the place of the old manual and water cart for the first attack.

(*b*). The importance attached to hook-ladder work in addition to the increased use of long telescopic ladders, many self-propelled.

(*c*). The introduction of self-propelled steam fire engines, some with electric traction, others travelling under their own steam.

(*d*). The careful study beforehand of the best methods of attacking fire in important buildings.

The authors of the Report in their Introduction make a notable point in suggesting that fire brigades dependent chiefly on motor appliances should include at least two classes of motor traction among their vehicles, so that failure of either electricity supply, or of stores of oil fuel or of petrol, such as may occur during strikes or in war time, should not deprive the brigade of all their means of traction at one time.

RECENT DEVELOPMENT IN ROAD MAINTENANCE.

A Lecture delivered at the S.M.E. by H. P. MAYBURY, ESQ., M. INST. C.E., *Kent County Surveyor, and Member of the Advisory Committee to the Road Board.*

THE subject of our roads is one which has, since the passing of the Motor Car Act of 1903, received perhaps more attention than almost any other engineering problem.

From the time of the railway boom, in the middle of the last century, and for 50 years thereafter, the roads of the country were thought to be of no national importance and were handed over to various local bodies to supervise and maintain, often with disastrous results. A local farmer was elected as surveyor and contractor for the upkeep of a few miles of roads through his particular parish. As ruts appeared, so a few pebbles were picked up off the land and laid in them indiscriminately, and these the traffic had to consolidate. Very soon the roads became quite unfit in the sense of being really ways for traffic. No better proof of this could be found than in the fact that wherever military manœuvres took place on a large scale —as at Salisbury Plain in 1872—at the end of a week, the wheeled traffic had turned the roads into a quagmire, through which men and horses dragged their weary way, the marching powers of both being practically exhausted by a mileage of not one half the distance they would have been able to accomplish without fatigue, upon roads well and efficiently maintained.

The passing of the Local Government Act of 1888, by which County Councils were created, saw the advent of a new order of things. In most counties, trained and qualified Civil Engineers were appointed to act as Chief Surveyors, the result of this scientific and skilled management being that in the 15 years to 1903, the date of the passing of the Motor Car Act, a vast improvement had been effected. The question of finance was in this as in everything else in this world, the all-important one. All expenditure had to be met by local taxation, and it was (as it is now) always more popular to strive for economy rather than efficiency.

Although the highway authorities of the county have been much abused for the condition the roads were in, in 1903–4, I am inclined to think this abuse was most unjust. Until 1896 the maximum speed permissible on any of our highways for any self-propelled vehicle was 4 miles an hour, and then such vehicle had to be preceded by a man carrying a red flag. In that year, 1896, self-propelled vehicles of

certain defined weights were allowed to travel at a maximum speed of 12 miles an hour, but very little advantage was taken of this altered condition of things, as at the time of the passing of the Motor Car Act (1903) it is estimated that there were not more than 1,000 self-propelled vehicles (other than traction and agricultural engines) in the United Kingdom, whereas by the end of the following year (1904) 51,549 motor cars and motor cycles were registered. The road engineers were not advised that this altered form of traffic might be expected. The revolution came upon us with as little warning as the British will receive of the invasion of the country, which certain alarmist journalists tell us is bound to occur at an early date. Parliament, in giving the self-propelled vehicle its charter of freedom, did not stop to enquire what effect it would have upon the roads. One cannot imagine an entire change in the rolling stock of one of our important railways being contemplated save in conjunction with the consideration of the capabilities of its iron roads and bridges to support and satisfactorily carry same. Before increasing weight or speed the railway engineer would have reported to his Board upon the strengthening of the permanent way necessary, and such works would have been undertaken before any alterations in the Company's regulations were sanctioned. How different in this case. The new traffic is legalized, and the several local governing authorities are expected to find out precisely what is best to be done to meet it, and also to provide *from the rates* the money with which to carry out the necessary improvement works.

Officers in charge of the roads under such conditions are entitled to sympathy rather than the abuse which from time to time is showered upon them by irresponsible persons. The various local governing authorities so little appreciated the necessity for increased expenditure that it was extremely difficult to get any additional sums voted; the result being that for the first year or two (*i.e.*, to 1905) the surfaces of the roads of the country seriously deteriorated.

In the County of Kent the problem became peculiarly embarrassing. For many years large quantities of the local ragstone and flints had been used, the greater part of the London and Dover Road being surfaced with those materials, which, pulverized as it soon was by traction engine traffic, raised the dust question in an acute form. I well remember in the summer of 1904 employing all the men I could get with buckets and brooms to collect the dust from the road surfaces and put same in heaps on the wastes adjacent. Having the direct charge of about 600 miles of main roads upon which each year up to 1903–4 some 50,000 cubic yards of ragstone and flints had been used, I soon saw it was hopeless to attempt to maintain the roads for the then traffic with the local material available, and in the following year my Council voted such a sum as enabled me to procure 74,000 tons of hard stone, such as syenites, basalts, whinstone and

granite. As this quantity was only sufficient to metal about an eighth of the whole, it was necessary that whilst improvement was made with this hard material, local stone in large quantities should still be purchased and used for urgent repairs. In addition therefore to the quantity of granite aforementioned, some 25,000 tons or yards of flints were obtained and used. Traffic continued to increase in volume, weight and speed, to such an extent, that even with the better material one could achieve little or no progress, but, thanks to an enlightened council, who consider efficiency with economy, a larger annual vote has been made, so that in the year ended the 31st March last I was enabled to purchase and actually use upon the 600 miles aforementioned no less a quantity of material than 128,504 cubic yards, or tons equalling 215 tons or yards to each mile, the cost of stone alone being upwards of £50,000.

The length of through roads in England and Wales maintained by funds derived from rates is 123,556 miles, 27,638 of which are main roads. The cost of maintenance in the year 1909 was nearly 4¾ million pounds sterling. This sum does not include the expenditure of Boroughs and Urban Councils in the maintenance of purely local streets. The total mileage of roads in the United Kingdom in 1906 is given as 228,439. The cost in *that* year being 15¾ millions, *now estimated to be 20 millions.* Self-propelled traffic continues to increase at an amazing rate. As already stated, in December, 1904—a year after the passing of the Motor Car Act—there were 51,549 light motor cars and cycles registered, whilst in December, 1909, these had increased to upwards of 190,000. Under the provisions of the Motor Car Act the Local Government Board was empowered to make regulations for the inauguration of the heavy or commercial motor. Such regulations were issued in 1904, and as a result we have (*a*) the steam motor lorry; (*b*) the steam motor tractor; (*c*) the petrol commercial motor. No complete statistics are available as to the numbers of these vehicles registered in England and Wales, but we know that in one year more than 6,000 were registered in London alone. There are 8,600 traction engines licensed.

With this revolution in the traffic using the roads it became imperative that different methods of maintenance and repair should be adopted. Given any one kind of vehicle, it is comparatively easy to meet the case, but it is by no means so to maintain one road to suit all. The light motor car moving at a high rate of speed could be economically served by the laying of a comparatively thin coating of hard material upon existing surfaces, treating this with a tar compound, and renewing same as became necessary. The smoother and more polished such surface became the smaller the cost of maintenance and the more economical, both in tyres and petrol, the running of the cars. Such a surface, however, would neither be suitable for horses nor for the iron-shod wheel of the commercial

motor and traction engine, consequently, the road engineer has had to adopt such measures, imperfect no doubt, but still fairly effective to suit all users.

Perhaps the most obvious defect in our roads is the insufficiency of their foundations. If cost were of secondary consideration, the engineer would strengthen the foundation of his road in the most up-to-date manner, and then lay on his coating of hard material or tar-macadam, taking care to make the surface as impervious as possible, so as to keep his foundation and road bed dry and unyielding. Since the days of Telford and Macadam, numerous textbooks have explained to engineering students how to construct a road, by putting in a solid foundation of hand-packed stone of large size, on which the surface metal should be spread. Unfortunately, even after the lapse of several generations, this desirable method is still almost entirely confined to textbooks.

The cost of so dealing with our main trunk roads would be enormous. A few years ago, the County Council of Hampshire, in conjunction with the War Office, proceeded to reconstruct some 10 miles of road in the vicinity of Aldershot. The road bed was formed to the proper curvature, and upon this, large blocks of limestone were laid, varying in thickness from 6" at the haunches to 14" in the centre. Upon this 4" of Rhenish columnar basalt was laid and consolidated. The cost of this work was close upon £20,000. It will be seen, therefore, that to deal in the same way (which is the textbook and no doubt the proper method) with the 27,000 odd miles of *main* roads in England and Wales would mean an expenditure of about 55 million pounds. As any such sum or even a third of it, is quite outside the range of practical politics, the road engineer has to satisfy himself by providing foundations by "accumulation," that is to say he endeavours, and invariably succeeds in laying down a little more material than is actually worn out, and so gradually,—very gradually, I fear, in some counties,—accumulates a support to his road, in the hope that at no distant date it may be of sufficient thickness to transmit the imposed load to the weaker subsoil, and so avoid the crushing through of the surface. It has been estimated by a reliable authority that to provide for ordinary wear and tear, and for an accumulation of 1" of thickness of surface only, over the main roads would mean an additional expenditure of 9 million pounds. If the foundation and subsoil, and the accuracy of cross fall be matters of great importance, equally so of course is the metal comprising the surface. For many years past road engineers have been making practical experiments in their endeavours to determine the relative values of the various materials available, and whilst I agree and recognize that experiments made in laboratories are valuable, still the results are not as trustworthy as those made under actual working conditions. So

much depends upon the nature of subsoil and upon the effect of atmospheric influences upon same. Whilst excellent results may be obtained with one kind of stone, say upon a chalk foundation, these may be extremely bad if the same material were laid upon yielding clay. Although it has been possible to obtain reasonably reliable information from the many experiments made, it has not been practicable to determine, in figures, the influences of subsoil and climate. As almost every district produces a stone of some description which has a certain value for foundation purposes; in the south-east of the country there are no volcanic rocks, and therefore we have to go very far afield to secure hard material.

The columnar basalts of Germany, the syenites of Belgium, the quartzites of France and the granites of Norway, in addition to those of the British Isles have been drawn upon to an enormous extent, and if we are to have strong, smooth and comparatively dustless and durable surfaces, still further tribute must be exacted. Here again it is difficult to determine relative values. The hardest material is not necessarily the best, in fact its hardness is often found to be a disadvantage. A very hard material is often an extremely difficult one to keep compact and tight. Again most of the basalts when broken by machinery have a tendency to flake, whilst a softer though tougher material breaks cubical. The result, in practice, is that the softer material is much more cementitious, keys together under the action of the roller and withstands the concussion of the high-speed self-propelled vehicle better than the harder, but less compact, surface. Even with the abandonment of the limestone and flint for surfacing, and the use of the imported hard stone, the dust nuisance, although minimized, is by no means effectively dealt with.

We have on the roads two very distinct kinds of dust; first that the result of the animal traffic, which is the most offensive, and secondly that which is due to the wearing of the road material, either on the surface directly under the traffic, or in the core of the road caused by attrition or rubbing of the stones by movement due to the loads passing over, and which dust works to the surface together with mud from a wet subsoil where the foundation and road crust is insufficient to prevent it. It has always been realized that excellence of construction goes far to reduce wear, and, therefore, to reduce dust and mud, still it has been fully understood that it does not by any means prevent it. Dust we have always had. It was a great trouble to our forefathers. The numerous pumps on the old Bath and other roads will bear witness to this, but as in our time watering to keep down the dust has been found to be impossible, we have had to resort to other methods. In 1856 Claus proposed to use a solution of calcium chloride or magnesium chloride for dust abatement, and in 1867 a Mr. and Mrs. Cooper were granted a patent for the use on

roads of a solution of common salt with chloride, such as calcium or magnesium. We have to-day in many counties the use of large quantities of calcium chloride, which is a by-product from the manufacture of alkali, and which is available at a nominal price at the works of Messrs. Brunner, Mond & Co., Ltd., in Cheshire. It can be, and is being applied to the roads both in liquid and in dry granular form. This material is doubtless an excellent palliative, but the measure of its value is entirely one of atmospheric conditions existing at the time of its application. At the request of Messrs. Brunner, Mond & Co., the Roads Improvements Association in 1909 appointed a Technical Committee to make experiments with, and to take observations from, the use of calcium chloride. I had the honour of serving on that committee, which was composed of three Engineers and a Fellow of the Institute of Chemistry. Extensive and prolonged tests were made in Middlesex and Cheshire. The report of the committee was, that whilst the use of this chemical was less injurious to ordinary roads than the watering now necessary for the effective abatement of dust would be, yet it was of little or no value to road maintenance, and when extensively used under bad climatic conditions, it produced a glutinous mud, which adhering to the wheels of vehicles, had the effect of pulling up the granite surface, thus accelerating disintegration. The cost of the use of calcium chloride obviously depends upon the amount of freightage to the point of user. In Cheshire, it is returned as a fraction of a penny per super yard, whereas in Worcestershire the cost is given as 1d. per yard, or from £40 to £60 a mile.

It is generally conceded that the nearest approach to the ideal road is obtained by the use of some bituminous material in some form or other. As long ago as 1834 one Cassell aroused a good deal of interest at the time, and has doubtless been the source of inspiration of numerous subsequent efforts. Cassell's specification, amongst other things, provided for the saturation of the road bed with oil obtained by the distillation of tar, and then coating it with tar, which he set on fire, extinguishing it by applying slag, cinders, etc. These he rolled into the heated tar, and he went on to specify that the efficiency of the cemented layer might be increased by adding other layers of tar and grit. This he provided for covering with broken metal, the interstices being grouted or run in from the top with distilled hot tar and sand. When this was cold Cassell applied a thick coating of distilled tar mixed with sand, etc. He then consolidated the whole. In 1883 Mr. Leopold Stiebel, of London, proposed a similar method, but with asphalte as his matrix. In 1890 Messrs. Hirsch and Reinisch applied for a patent for a similar method, but using ground stone and pitch as their binder.

In 1902 a Mr. F. J. Warner, an American, patented in England what he described as a "bituminous material road," which is identical

with the system of which a year or two ago so much was heard, and which was described as the "Gladwell" method. As, doubtless, most of you know, this system provides for the laying upon the old surface of a thickness of from ¾" to 1½" of granite chippings, mixed with tar, upon which the metal is imposed, the idea being that the passing of the steam roller over same induces the matrix to work up and fill the voids between the stones. After sufficiently rolling, a layer of the same matrix is spread on the surface and rolled, this being supposed to make the whole impervious and hard. Very little indeed is heard of the process to-day. In practice it was found not only extremely costly, but under heavy traffic it was impossible to keep it from moving, the tar in the bottom matrix acting as a lubricant, keeping the whole alive, with the result that a wavy and irregular surface was soon in evidence. A section of a main road in this county between Erith and Crayford was laid in accordance with the "Warner" or "Gladwell" specification, at a cost of about 2s. per super yard. The result was not sufficiently attractive to warrant an extension of the process.

About 1902 also; Mr. E. P. Hooley, M. INST. C.E., the popular County Surveyor of Nottingham, patented and introduced his method of coating slag macadam, etc., with a mixture of tar, pitch, Portland cement and resin, and which is so well known to you under the name of "Tar Mac." This is an extremely simple and comparatively inexpensive material, and in the vicinity of iron works where blast furnace slag is produced, and is a waste product, it has immense advantages. The slag, in a molten state is run into iron trollies where it solidifies. It is then tipped from the lorry on to the floor of a covered shed, and sledged up to sizes capable of being fed into a stone-breaking machine. In this it is reduced to proper macadam sizes, afterwards being sorted by revolving screens. As it leaves the screens for the respective storage hoppers, it is met by a spray of heated tar compound. From the storage hoppers it is loaded direct into railway trucks or carts, and is ready for use. It will be seen therefore with what an immense advantage tarred slag starts its commercial career. There are no quarrying costs, and no drying or heating, and therefore small labour charges for handling. The greatest cause for wonder is that only a small quantity, comparatively, has yet been used. One of the works of the Tar Mac Company was at Denby near Nottingham, their chief works, however, are at Ettingshall, Wolverhampton. Notwithstanding the geographical positions of the works, only a small portion of the main roads of the county of Nottingham have been coated with "Tar Mac," whilst the county of Stafford, of which Wolverhampton is the "hub," has hardly deemed it worthy of trial, preferring instead to purchase the excellent basalt as supplied from the south Shropshire quarries, known as Clee Hill. Railway carriage makes the use of the Wolverhampton product prohibitive in the neighbourhood of

the Metropolis and south thereof. A short section of main road laid with "Tar Mac" can be seen in the village of Wateringbury in this county, but as the material cost about 20s. a ton, let it be never so good, it is quite outside our financial possibilities. Let me give you an example:—The railway carriage for "Tar Mac" from Wolverhampton to Maidstone is 11s. 6d. a ton, the covering area of which quantity would be about 10 super yards. Add this to the cost of the slag preparation which would be from 7s. to 7s. 6d. a ton. Say 18s. a ton at Maidstone or equal station. Now compare this with say Belgian syenite. This latter is delivered at Maidstone at 9s. 6d. per ton, the covering area of that quantity being from 11 to 12 super yards. The haulage, labour and rolling charges for each would be much the same, so you will see that "Tar Mac" would cost, laid complete, at least 1s. per yard super more than syenite, or assuming 10,000 yards to the mile, say £500 per mile in excess. For £60 per mile the syenite road could be treated with two coats of heated tar compound making it almost as impervious as, and quite as dustless as the "Tar Mac." Apart from cost, "Tar Mac" has one decided disadvantage, wearing as it does extremely slippery, and being very hard, animals of all kinds experience much difficulty in obtaining a foothold. For rubber-shod self-propelled traffic, a "Tar-Mac" road is ideal, there being very little dust in summer and an absence of mud in winter. What, doubtless, *has* retarded its use, has been the general weakness of the foundations of the roads, the engineers being of opinion that they would be courting failure by laying expensive materials, which might be sheared through by traction engine traffic in consequence of insufficient vertical and lateral support.

Again, before using impervious material, it is necessary to raise the sides or haunches, in order to flatten the cross fall of those roads which may have a camber suitable for ordinary untreated macadam. The cost of these necessary improvements to foundations and cross fall on the main roads only of England and Wales is so vast, that even if the cost of providing the impervious surface was much less than it is, there are no prospects at present of finding the funds to enable the works to be carried out upon a large scale.

There are many other proprietary articles made in more or less the same way as "Tar Mac," the difference being that granites or syenites are used instead of slag, but like "Tar Mac," unless such material can be produced in the neighbourhood near which it is required to be used, their costs are prohibitive. Two of these proprietary materials are known as "Tarlithic" and "Quarrite." Samples of both can be seen in this county, some of the former having been used in the Borough of Gillingham, whilst a section of the latter has been laid on the road inside the confines of the Cavalry Barracks at Canterbury.

The county of Kent has always been noted for its ragstone tar paving which has been extensively used for many years past in the

coast towns for sea front promenades and footpaths; for the paving of school playgrounds, railway station platforms, etc. The abolition of the use of the Kentish ragstone as road metalling, seriously affected an established county industry, and threw upon the unemployed labour market a large amount of unskilled labour. The ragstone quarry owners are now engaged in endeavouring to regain the ground thus lost by manufacturing tarred macadam for main road requirements.

For the last year or two experiments have been made with this material. Some three years since a section of the London-Folkestone Road was placed by the County Council at the disposal of one of the manufacturers, an agreement being entered into by which for an annual payment for each of five years the contractor laid with tarred macadam and maintained same to the satisfaction of the County Engineer. This section has not been an unqualified success, but as a result of the experiment it was discovered how to improve, and about 14 months ago a longer section—1¼ miles—on the London-Hastings Road between Bromley and Sevenoaks was laid with the same material. This *has* been a success up to the present, and so satisfied was my committee with it, that in the present year we placed orders with the several manufacturers in the county for 20,000 tons. I suppose about half this quantity has now been laid upon all kinds of subsoils and varying strengths of foundation. Kentish ragstone, although softer than slag, has the advantage of giving a better foothold for horses. It is essential, however, that it should be treated as soon as laid, with a good covering coating of heated tar compound, and if clean sharp angular grit or granite chippings be applied whilst the tar is hot, an excellent wearing surface is obtained. Close attention has been paid to these tarred macadam surfaces, and the moment the ragstone has shown signs of abrasions, another coat of tar and shingle has been applied. Although the ragstone is quarried and treated in the county, it is still at a financial disadvantage with imported hard material to the extent of about 3d. per super yard, or £125 per mile, and therefore it must be more durable in order to justify a substantial extension of its use.

We are now engaged in making experiments with flints treated in exactly the same way as the ragstone. A section of about ½ mile will shortly be laid with this "tarred flints" in the Isle of Grain, and a second section will be laid on the main road between Gravesend and Wrotham.

Again, another experiment is being made in the preparation of another tarred macadam, the material being shingle, from the beach. This shingle is burnt in a brick kiln, the pebbles by being subjected to the heat bursting and becoming angular in shape. Upon being taken from the kiln, the shingle is screened so as to remove the dust, and whilst warm is treated with freed tar. A short section of road has been laid with this material about midway between Rye town

and the harbour, and at this moment a short section of the county main road is being laid with it between Hythe and Appledore Should this latter process be a success—and I am hopeful—there is no limit to its possibilities, as the shingle can be procured for a few pence per ton.

Various other experiments have been and are being made upon the county main roads. Quite recently, in July last, a section of the London-Folkestone Road, some 2 miles west of Maidstone, was treated as follows :—The surface, a granite one, was scarified, the old material being removed. Upon the formation thus prepared a layer of 2¼ Belgian syenite granite was laid and rolled as tightly as possible, dry. Various grades and qualities of bituminous binders were purchased and used in grouting in defined sections. These binders, which are delivered in solid block form, are melted in large boilers, the liquid being poured from lipped buckets into the interstices of the road surface, the quantity of the binder required being about half a gallon per super yard. Whilst the material is hot, sharp washed angular grit or granite chippings are applied and the roller passed over. The whole section was subsequently treated with a top dressing of heated distilled tar, when more clean grit was applied. The cost of this work has been about 2s. 10d. per super yard, much the same as that of "Tar Mac," and considerably less than "Quarrite" or "Tarlithic." It cannot fail to be superior in wearing properties to "Tar Mac" because the material is an excellent syenite road stone as compared with what, after all, is only a blast furnace cinder. Another short section on the same road, but east of Maidstone, has been laid in the same way, the grouting and binding material in this instance being a preparation known as "Roadoleum," which is a by-product from the refinement of petroleum, and is supplied by the Anglo-American Oil Company. This material works freely and well, and gives good promise, but whether it would ever be obtainable at reasonable and comparative prices I have no means at present of ascertaining.

Another experiment with the same material applied in precisely the same way is to be made close to the boundary of the Metropolis and where the road, in addition to supporting the heavy traffic between the county and London, has recently had imposed upon it the additional burden of a frequent motor bus service from Sidcup to Oxford Street.

The permanent value of these experiments time alone can decide. I have said enough thereon I am sure, to show you that at all events the County Council of Kent is alive to its responsibilities, and is determined to be in the van with its roads, as it is with its cricket and its territorial forces. It is conceded, I think, by persons competent to express an opinion, that, taken as a whole, at the present moment the main roads of this county are second to none.

If this be true, and I know it to be so only by comparison, I assure

you, it has not been attained without the expenditure of large sums of money, *all derived from the rates*, and the continuous labours and perseverance of the Council's technical staff. We have used large quantities of local materials to strengthen foundations and reduce camber, have procured and laid upon same the best and toughest material to be obtained, have consolidated same in the best known way, and whilst the surfaces were yet good, dealt with the dust nuisance and made the roads impervious by repeated coatings of heated tar. To give you some idea of the magnitude of this latter work. In the year ended the 31st March last, the tar-painting bill alone came to nearly £16,000, about 650,000 gallons of tar having been used in coating 303 miles of surface. In the present year, we set out to use a million gallons of tar, and I do not think when the returns are received from the several divisions we shall be very far short of having accomplished this.

Other counties are doing more or less in this direction, Surrey and Middlesex (both now being comparatively small counties), having treated practically the whole of the surfaces of their main roads with tar on granite or syenite.

In addition to creating the necessity for improvement in the surface of the road, the self-propelled traffic has put upon the local governing authorities still further responsibilities, such as the reconstruction and strengthening of bridges and culverts, the provision of footpaths for pedestrians, and the improvement of dangerous corners. In the year ended the 31st March last the expenditure upon such works was close upon £10,000. The total main road bill of the county for the last financial year was £154,263 for maintaining and improving 750 miles of main roads, made up as to 580 in rural districts and 170 in boroughs and urban districts, this expenditure being equal to a charge of about £206 per mile.

The bridge question is a very important one, closely allied and inseparable from the roads, because as we know the chain is no stronger than its weakest link. From a national and military point of view all bridges under roads should be capable of supporting the heaviest load legally allowed to be upon the roads. For instance a traction engine empty may weigh 16 tons, and this, when carrying its complement of coal, water and tools may easily touch from 18 to 20 tons. A road authority is not required by Parliament to have its bridges sufficiently strong to support such traffic, but may by notice prohibit its passage over a particular bridge. Public opinion, however, is generally sufficient to influence County Councils to strengthen, but this has no effect upon companies trading for profit, whose canals or railways honeycomb the otherwise continuous highway. Many anomalous structural conditions have been revealed by detailed inspection of a large number of highway bridges. It has been by no means unusual for instance to find that a steel bridge has its main

girders of ample cross-sectional strength for carrying heavy traffic, whilst its cross girders have proved to be quite inadequate to bear concentrated rolling loads. Such conditions show that the bridges have probably been designed by draughtsmen who, in order to save trouble, have based their calculations upon loads per square foot *dead*, rather than upon rolling loads combined with dead weight, and some few cases have occurred where the reverse condition as to girders has been shown. A case in point was one quite near to us. In 1856 a Railway Company obtained powers to construct a railway from Sittingbourne to Sheerness, and in connection therewith to construct a bridge—King's Ferry—over the Swale. Plans were deposited with the Board of Trade, and approved by that department, the bridge being constructed strictly in accordance therewith. Although by the defect in the design of its cross girders, the bridge was never theoretically capable of supporting traction engine traffic, yet by the laches of the Company's officials, road engines were permitted to cross, with the ultimate result that an engine fell through into the Swale. As the Company was only required to keep the bridge up to the standard existing at the date of its construction 1856, which was in pre-locomotives on highway days, a notice was erected prohibiting all traffic having a load of 5 tons and upwards upon four wheels. The result of this prohibition was to shut off the Isle of Sheppey from the mainland, so that no agricultural engine for ploughing or threshing purposes could be taken in, nor could a heavy motor car cross. This appeared to the County Council to constitute a great injustice to the agriculturists in the island, placing them at a disadvantage with their neighbours on the mainland. Negotiations were, in consequence opened with the Railway Company with the result that an agreement was arrived at, subsequently consolidated by Act of Parliament, by which the County Council contributed in kind between £1,400 and £1,500 towards the strengthening of the cross girders, so as to enable heavy traffic to get into the island. This work was accomplished during 1909, and the restrictions imposed are consequently a thing of the past. The law at present only requires owners of private bridges to maintain them to their original standard of strength.

Many railway bridges under the roads in this county are suffering from the defect of inherent weakness, and most people have seen, I suppose, on such bridges, notices intimating that the bridge is only equal to —— tons. Of what use would such bridges be in the event of a national emergency ?

Gentlemen who are responsible for transport of heavy guns, ammunition, and for the Commissariat Department may find when the enemy has arrived at Dover that the bridges are down, not by the enemy's depredations, but because a transport locomotive has fallen through on to the railway.

An endeavour has been made by the Traction Engine Owners' Association, by that of the Commercial Motor Users, and by County Councils to impress upon the War Department the extreme importance of remedying matters, but so far as I know, with little or no result. There are certain advocates of an amendment of the law which would compel railway and other companies to strengthen their bridges *pari passu*, with increasing traffic. This is a gospel of perfection which would not be acceptable to any Parliament because it would be unjust to the trading companies.

It should be possible, however, for an enquiry to be held by, say, the Local Government Board, upon the representation of any Government or local authority, or by any body of aggrieved persons, and the Local Government Board should have the power to order that a bridge should be reconstructed in such a manner as to be capable of supporting present-day traffic, with an ample margin for future development, and that the cost of such reconstruction should be borne in such manner as a qualified engineering arbitrator, appointed by the Board, should determine. As the trading company would receive some betterment by the provision of a new bridge in lieu of one which had seen many years of service, a part of the cost should be borne by them, and the balance should be met by charges upon the Imperial and local exchequers as may be decided. As the nation and the local community would benefit by the unrestricted use of the highway, such a division of cost would be amply justified.

I feel that no apology is needed for annexing these few remarks upon bridges to a lecture upon Road Development to a military engineering audience. Responsible as you are or will be for national defence, it will readily occur to you how very important it is that these defects in the otherwise excellent lines of transport should be dealt with by the powers that be at an early date. These prohibited bridges are to be found over every canal and railway in the United Kingdom, but perhaps, for the mileage of roads traversed, the trouble in the South of England is most pronounced. The money value of good roads to the nation is enormous. What is inefficient is never in truth cheap. And in no instance is this fundamental maxim more certainly true than in the case of roads over which a large traffic passes. Make haulage easy and swift, and at once the conveyance of material of all descriptions being cheaper, the price in the competition market for sales will necessarily fall. Locomotion will always be cheaper on good roads than bad, and this directly constitutes an addition to the wealth-producing power of the country, diminishing the cost of wear and tear of animals and carriages, and the expense of the journey to travellers, by facilitating and accelerating the rapid transaction of business by intercommunication between one place and another. The improvement to the roads which has so satisfactorily commenced, must be diligently pursued. That increased volume of traffic and

speed of same must mean increased expense, no thinking person will contest. The difficulty, particularly since 1903, has been that the incidence of charge has not been equitably distributed. Now Parliament has to some extent remedied this by the increased duty upon motor cars, and by the imposition of the Petrol Tax, the money to be derived thereby to be expended upon the improvement of the roads. This appears to me to be eminently sound finance and equitable both to the motorist and to the road authority.

As to procedure, I venture to predict that for the next few years the nearest attainment to the ideal in road maintenance will be found in :—

1. Building up the roads as strongly as possible, reducing camber to an uniform cross fall of 1 in 30.
2. Coating the surface with the best obtainable hard material broken to a gauge of not less than 2" and not larger than $2\frac{1}{2}$" well rolled and consolidated, only clean hard gravel and chippings being used as a binding agent.
3. When the whole has dried out, thoroughly sweep the surface and apply a dressing of heated tar compound, covering same lightly with clean sharp sand or fine granite chippings.

A surface so constructed is the cheapest form of improved road to provide, is almost dustless, gives good travelling for traction engines and heavy motors, and is the least slippery for horses. I am not sure that any other method, at no matter what expense, could be made quite as satisfactory for all users of the roads.

The new Road Board which has been brought into existence to disburse the money derived from motor and petrol taxation, is in the position of a trustee of these funds, and the Board will doubtless hold the scales evenly, so that the owners of vehicles will find that the payment of these demands is in fact an investment in a gilt-edged security, because the comfort to be derived and the saving in wear and tear will be out of all proportion to the sum demanded by the Inland Revenue authorities.

If in the course of my remarks I have too frequently referred to the county of Kent, I am sure that I shall be forgiven. By virtue of the position I have the honour to hold, it follows that my experiments and knowledge of results must, for the most part, have been obtained within its confines, and also because we have endeavoured to keep ourselves in the forefront, by trying, with more or less success, the various processes which have never lacked advocates. The record of my mistakes and failures, as well as that of whatever little success I have achieved, is always at the disposal of the S.M.E., and I can promise, at all events, to show what to avoid, if not what to emulate.

TRANSCRIPT.

THE ARMY FIELD ENGINEER SCHOOL OF THE U.S. ARMY.

In the February number of the *R.E. Journal* details were given of the Engineer School at Washington. In the U.S. Army Order No. 69 of April 20th, 1910, details are given of the Army Field Engineer School and these are now added, as they are likely to prove of interest.

The Army Field Engineer School.

37. This school will be known as The Army Field Engineer School. Its object is the preparation of officers of the Corps of Engineers and of engineer officers of the organized militia for the better performance of their military duties.

38. The commandant and the secretary of The Army School of the Line will be the commandant and the secretary, respectively, of The Army Field Engineer School. The assistant commandant will be an officer of the Corps of Engineers with grade not lower than that of major.

Student Officers.

39. Selections of student officers will be made as follows:—

(*a*). The Chief of Engineers will submit to The Adjutant General of the Army, not later than January 1st of each year, the names of not less than 2 nor more than 10 officers of the Corps of Engineers for instruction in the school.

(*b*). There may also be detailed such engineer officers of the organized militia as may apply for entrance, subject to the provisions of paragraphs 5 to 17, inclusive, excepting paragraph 9 of this order.

The foregoing details will be announced in orders from the War Department.

Examination of Militia Officers for Admission.

40. The following will be substituted for the examination in military subjects as set forth in paragraph 9.

(*a*). Administration. (Consult especially the following paragraphs, Army Regulations, 1908:—6, 9, 13, 14, 15, 16, 18, 57, 76, 77, 80, 83, 133, 134, 137, 186, 189, 190, 194, 195, 201, 212, 223, 224, 229, 449, 451, 452, 743, 765, 784, and 1510 to 1527, inclusive).

(*b*). Manual of Guard Duty.

(*c*). Manual for Courts-Martial.

(*d*). Field Service Regulations (Articles II., III., IV., and V.).

(*e*). Manual of Field Engineering, Beach (Chapters I.—X., inclusive).

(*f*). Topographical Surveying and Sketching, Rees (Chapters I., II., III., and XV., omitting analytical solutions).

In lieu of examinations in any of the foregoing subjects certificates of proficiency from garrison schools in such subjects will be accepted.

COURSE OF STUDY.

41. The course of study will be embraced in three departments, as follows:—

I.—The Department of Engineering.
II.—The Department of Military Art.
III.—The Department of Languages.

I.—ENGINEERING.

The study of this subject will be divided into two parts, theoretical and practical. Theoretical instruction will be by lectures, conferences upon assigned lessons, and written examinations. Practical instruction will be by problems and terrain exercises.

The course will comprise the following subjects and fields of inquiry:—

(*a*). Military map making:

Surveying.
Sketching.
Map projection.
Map reproduction.
Photography.

(*b*). Organization, duties, and equipment of engineer troops.

(*c*). Field fortification:

Hasty intrenchment.
Deliberate fortifications.
Sieges and siege methods.
Demolitions.
Mining.

(*d*). Lines of communication:

Military roads.
Military railroads.
Military bridges.
Animal transportation.
Mechanical transportation.

(*e*). Castrametation:

Water supply.
Drainage.
Shelters.

II.—Military Art.

The study of this subject will be in all respects identical with the study of the same subject in The Army School of the Line, and will be conducted under the direction of the assistant commandant and instructors of that school. Student officers of The Army Field Engineer School will be graded in the Military Art course in the same manner as student officers of The Army School of the Line.

III.—Languages.

The course in languages will be elective, and will comprise instruction in French or German, as preferred by the student officer: Provided, That no student officer will be permitted to elect either of these languages unless he has a good conversational knowledge of Spanish. If not, he will take the same course in that language as is prescribed for The Army School of the Line. The course in each language will comprise instruction in reading, writing, and speaking, with a special view to acquiring a conversational knowledge of the language. Instruction will be given by conferences, lectures, and conversational practice.

Thesis.

42. Each student officer will prepare a thesis on some professional subject approved by the academic board and submit the same in the required form prior to June 15th of each year.

Co-operation.

43. The student officers of The Army Field Engineer School and the engineer troops on duty at Fort Leavenworth will be used to co-operate as far as possible with The Army School of the Line, The Army Signal School, and The Army Staff College in terrain exercises, manœuvres, and staff or tactical rides, to the end that student officers of all these institutions may obtain the maximum benefit from the exercises prescribed.

EXAMINATIONS.

44. Any student officer of this school whose progress in any of his studies is not entirely satisfactory to the academic board will be examined therein under the provisions of the rules governing examinations and proficiency prescribed in paragraphs 19 to 24, inclusive.

RECORD, ARRANGEMENT AND PUBLICATION.

45. For record at the school and at the War Department the members of the class, upon the satisfactory completion of the course, will be designated as graduates. The term "graduate" will signify that the student officer has attained a proficiency in all of his studies satisfactory in every respect to the academic board or has obtained at least 75 per cent. in each of those subjects in which he has been examined or re-examined.

In all published lists the names of the graduates will be arranged in alphabetical order.

REVIEW.

ALGO DE POLÉTICA NAVAL.

The author of this pamphlet, Colonel Don José Viciana of the Spanish Engineers, has been so good as to send a copy of his work to the R.E. Institute. It consists of four chapters, the first containing a description of the various types of vessel to be found in a modern fleet, the second dealing with coast defence, the third proposing a new type of floating battery or concrete monitor, and the fourth devoted to a short consideration of Spanish naval policy.

The chief interest of the work lies in Chapter III., in which the author makes the novel proposal to construct vessels, protected by armoured concrete and provided with a powerful armament for use in coast defence. He suggests vessels of 37,000 tons displacement, armed with four 9·2″ and six 4·7″ guns mounted in concrete cupolas 6′ 6″ thick, placed on an armoured concrete deck 12″ in thickness. The battery will consist of two essential parts, a deck of ordinary concrete 5′ 6″ thick, inclined at an angle of 11° 20′ with the horizontal, resting on an under deck of armoured concrete 12″ thick, which is supported by pillars of armoured concrete, resting on the flat bottom on the vessel. The hull of armoured concrete is divided up into a number of compartments and the author calculates that it would have ample strength to resist the shock of a torpedo exploded against it. The dimensions of the battery are approximately 260′ long, 180′ wide, and 36′ in depth. It would be driven at a speed of 4 knots by two 500-H.P. internal combustion engines.

The author estimates that the cost of the battery would be about £50,000 for the hull and about an equal amount for the armament and engines, or a total of £100,000.

In Chapter IV. the author considers that the two battleships of 15,700 tons, the *Alfonso XIII.* and *España*, which are being built at Ferrol for the Spanish Navy, will be of very little use to it, and that it would have been far preferable to have spent the money which they will cost on small cruisers of 3,500 tons, armed with from 12 to 15 4″ or 4·7″ Q.F. guns with which to attack an enemy's commerce. He approves the construction of 3 destroyers and 24 torpedo boats which are to be laid down at Cartagena, and considers that submarines should also be provided.

'M.'

NOTICES OF MAGAZINES.

REVUE MILITAIRE DES ARMÉES ÉTRANGÈRES.

May, 1910.

THE GERMAN IMPERIAL MANŒUVRES OF 1909.—A long account of the operations is given, followed by various comments, of which a *résumé* follows:—

(1). As far as the infantry is concerned, the most noticeable point is the length of the marches they made:—the 39th Division did 95 kilometres in 3 consecutive days; the 14th Corps 135 in 4 days; and the 1st Bavarian Corps 30 to 45 in 1 day. These marches were undertaken in very hilly country, on bad roads, and in detestable weather; it is however only fair to note that the troops suffered severely from them, and that the percentage of stragglers was greater than usual.

(2). *Cavalry.*—The country was very favourable to the action of cavalry, and much use was made of dismounted action. The cavalry of both sides was however far too prone to remain stuck to the flank of the force it was attached to. The cavalry is armed with sword, rifle and bayonet.

(3). *Artillery.*—Much use was made of the heavy artillery, and in spite of the bad state of the ground it was always possible to bring the heavy batteries into action. All the artillery seemed thoroughly imbued with the spirit of the regulations and paid the greatest attention to supporting its infantry. The batteries often came into action in open positions without making any attempt at concealment or to entrench.

(4). No cyclists took part in the manœuvres.

(5). *Machine Guns.*—To each cavalry division was attached a machine gun detachment of 6 guns and 3 ammunition wagons. The strength of the detachments was 87 men and 54 horses. Machine gun companies of 6 guns each were also employed, one with each infantry regiment. Sixteen of these detachments, or 96 guns in all, were employed on the manœuvres.

(6). *Dirigible Balloons.*—The airship "Gross 2" was employed; it was provided with a wireless telegraphy apparatus. A special hangar was erected for it. The experiment does not appear to have been a success, and the wireless apparatus did not come up to expectations.

(7). *Communications.*—On each side the headquarters were connected to the army corps, and in the case of the Blue side to the airship also, by means of wireless telegraphy. A detachment of telephonists was attached to each infantry division. The telegraphic and telephonic communications of the two armies were very satisfactory; 140 motor cyclists

were also used. After many experiments, the Army Council has at last decided on the adoption of a 5-H.P. 2-cylinder motor cycle as the most useful pattern of vehicle of its class.

THE CHINESE ARMY IN 1910.—The Chinese Army now consists of:—(1). The new Regular Army (Lou-Kiun). (2). The Auxiliary Police Force (Siun-fang-toei). (3). The modern Police Force (Siun-K'ing-Kiun). (4). The contingents of the Mandchu Banners (Pa-K'i). (5). The remnants of the old army of the Green Banner (Lou Yng). (6). The rural Militia (Toan-lien). (7). The Mongolian and Tibetan contingents. (8). The river troops (Choei-che-ying, and Choei-che-Kiun-K'ing). All the above forces, except (3) which is under the Minister of the Interior, are directly under the General Staff and the War Minister. Great encouragement has been given to the army, with the idea of abolishing the old contempt of the civil mandarins for the military ones, new schools for the training of cadets have been opened, and examinations have been instituted to ensure that no one can obtain a commission without certain definite educational qualifications.

With reference to the various constituent parts of the army, the following are brief notes as to their respective strengths, efficiency, etc.:—

As regards (1):—Its strength is 152,565 men, of whom 120,000 are fully trained and could appear on a modern battlefield with a fair chance of success. It drills well in close order. The infantry knows how to make use of the ground, but shoots badly, whilst the cavalry is as yet insufficiently trained, rides badly, and is not yet thoroughly imbued with the cavalry spirit. Practice camps are as yet too rare in the field artillery, and although the engineers are comparatively well trained, the supply and transport corps requires organization, and the departmental corps are as yet non-existent. Finally although the progress since 1903 is extraordinary the discipline is rather lax and the operations of the younger generals savour still somewhat of the textbook.

As regards (2) these are but temporary troops, which will be abolished when the divisions of (1) are provided with their full complement reserves. They are employed to guard roads, railways, and for police duties generally.

(3) is efficient, but cannot be reckoned on as a serious military force, so occupied is it with its police duties.

As regards (4):—Of 5,000,000 of Manchus, 227,000 are obliged to serve as soldiers, of which 33 per cent. may be considered as efficient, and 67 per cent. as having undergone no military training at all.

(5) is absolutely useless and will be completely abolished within the next three years.

(6); of these the only militia of any military use is that of the Yunnan.

(7); the strength of this contingent is about 112,000 men, of whom only 11,000 to 12,000 can be considered as efficient, the remainder being armed with such obsolete weapons as bows and arrows, flintlocks, breechloaders, and similiar curiosities generally found in museums.

(8); these troops have hitherto been a collection of units entirely independent of one another, they are now however to be amalgamated

and reorganized; the tendency of the Chinese Government at present with reference to them, is to spend too much money on the gunboats, whilst the men themselves are not trained or equipped sufficiently to get the full value out of the good *matériel* with which they are provided.

To sum up:—Since 1903 China had made progress, in as far as her army is concerned, but her officers and N.C.Os. are not as yet trained, her General Staff lacks experience, her artillery armament is not uniform, and her musketry instruction and remount depôts very poor. All these faults will disappear the day that more funds for the army are forthcoming.

MILITARY NEWS FROM DIVERS COUNTRIES.—*Germany.*—A large number of small motor cars, of 8 to 12-H.P. have been recently acquired by the experimental branch of the communication troops; they are to be used at present to train chauffeurs and it is not improbable that they will eventually replace motor cycles as the means of locomotion of despatch riders. The new regiment of Saxon Hussars, which is to be raised on the 1st October, 1910, will be clothed from the very beginning with the new grey field service uniform; on the other hand the Prussian cavalry regiment raised on the same date will retain the old uniform. The German remount department's reports for 1909 are very satisfactory, and show that the increase in the use of the automobile, and the increase in breeding of heavy draught horses has by no means injured the breeding of the remounts; but on the other hand, their price has gone up from £50 in 1906 to £53 10s. in 1909. The increased hardships of manœuvres during the last few years have told heavily on the cavalry horses, with the result that the inspector-general of the cavalry has taken the following steps:—

(1). The daily hay ration is increased.

(2). The hours of the cavalry on manœuvres are shortened.

(3). As far as possible the use of bivouacs by mounted troops is abolished.

Spain.—The strength of the army of occupation at Mellilla, has been reduced from 37,000 to 30,000 men.

Italy.—The new grey-green field service uniform is now obligatory for officers when on duty with troops so clad. They are however not to wear it at the theatre or off duty after 3 p.m.

A. H. SCOTT.

RIVISTA DI ARTIGLIERIA E GENIO.

September, 1910.

BRIDGES OF BOATS ANCHORED TO A CABLE.—Among the various kinds of military bridges which have not up to the present been of great practical use because they are not always of easy construction but which offer advantages under certain circumstances, are some which are worthy

of examination because of their use to engineer troops. Bridges of boats anchored to a cable are a good instance. The excellent results obtained with bridges of this kind, in Switzerland, in various trials on the Aar would seem to point to their introduction in the programme of instruction in the construction of military bridges for that nation. A careful study of the statical calculations in connection with such bridges has been made by Lieut. Huguenen, and was published in the *Revue Militaire Suisse* of September, 1909.

Bridges of this kind present the following advantages: independence of the depth of the rivers, and variations in the level of the water, greater security from losses caused by floating bodies, possibility of construction during the night and without danger.

In order to calculate the principal elements of construction of such bridges, it is necessary to determine beforehand all the external forces which act on the restrained body, and long and numerous trials are indispensable. An absolutely rigorous calculation has considerable difficulties, but the problems may be simplified. The fundamental hypothesis presented in the study is that which relates to the nature of the curve assumed by the cable under the action of various forces. It is admitted that this curve has the form of a catenary, or it may approximately be that of a parabola. The bridges which have been constructed up to now have shown clearly that this simplification may be accepted without prejudice to the grade of exactness required for a work of this kind.

Determination of External Forces.—The author commences by describing the method employed for determining the tension produced by a boat, variously loaded, upon the restraining rope.

Three different methods of keeping the boats in their places were tried:—

1st. Normal anchorage with ordinary anchors.
2nd. Anchorage to the cable by means of a restraining rope of 20 m. in length.
3rd. Anchorage to the cable by means of a rope 7 m. in length.

The following results were obtained with a boat of 2030 k.g. displacement and a current of 3·5 m. per second.

Tension on the restraining rope: 116 k.g. with the 1st method of anchorage.

Tension on the restraining rope: 75 k.g. with the 2nd method of anchorage.

Tension on the restraining rope: 55 k.g. with the 3rd method of anchorage.

The anchorage to the cable with the above current velocity produced on the restraining rope a tension only about half of that of an immersed anchor.

The author gives very elaborate calculations, and drawings and sections for the calculation of the tensions on the cable for boats of different displacements and for different velocities of the stream.

MISCELLANEA.—*France.—La France Militaire* of the 2nd September announces the invention of a new smokeless powder, by the photographer Guichard, which is more powerful than that now in use in the French Army. From comparative experiments made near Montciel, it appears that with the same amount of powder the bullet of the Lebel rifle penetrated 635 m.m. in a certain target when the regulation powder M was used, while with the new Guichard powder the penetration was 732 m.m. This new explosive is, further, absolutely free from smoke or smell; is very stable, and is not influenced by damp or heat (it does not decompose at a temperature of 70° Centigrade); it does not explode by shock or under pressure; it burns slowly, developing a progressive force, and does not leave a residue like that of the powder M. The inventor has requested the Minister of War to make trials by a competent commission of this new product.

Telephonic Material for the Infantry.—La France Militaire also states that telephonic material is now distributed to infantry troops, and that it is composed essentially of complete micro-telephonic stations, with material for the lines composed of steel wire. All the material is very simple. The instruments for the stations are packed in portable bags, which are carried by the telephonists either on their belts or in some other manner. A limited number of men, who have received the necessary instruction and who understand the repairing of the instruments and apparatus, are employed on this work. The extension of a telephonic line is very rapid, so that communication on the field of battle can be fully maintained by this means.

REVIEW OF BOOKS.—*Count Camillo Benso di Cavour.*—On the occasion of the centenary of the birth of Count Cavour, Colonel Turletti has published the present volume in which the life of this famous Italian statesman is depicted in the succinct and simple form that is suitable for a work dedicated to the people. The pages of this valuable book are inspired with a tone highly educational and moral; are full of the sound instruction which, as the author states, we derive now by recalling the wonderful successes gained by men inflamed with the purest patriotism, aspiring with all their energy for the liberation and glory of their country. It is expected that this fine publication will be widely diffused among all classes of the population, and will tend to perpetuate the cult of the ancient patriotism, and inspire the thoughts of the new generation.

EDWARD T. THACKERAY.

ENGINEER RECONNAISSANCE IN UPPER BURMA.

Scale—4 Miles to 1 Inch.