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THE INSTITUTION OF ROYAL ENGINEERS.

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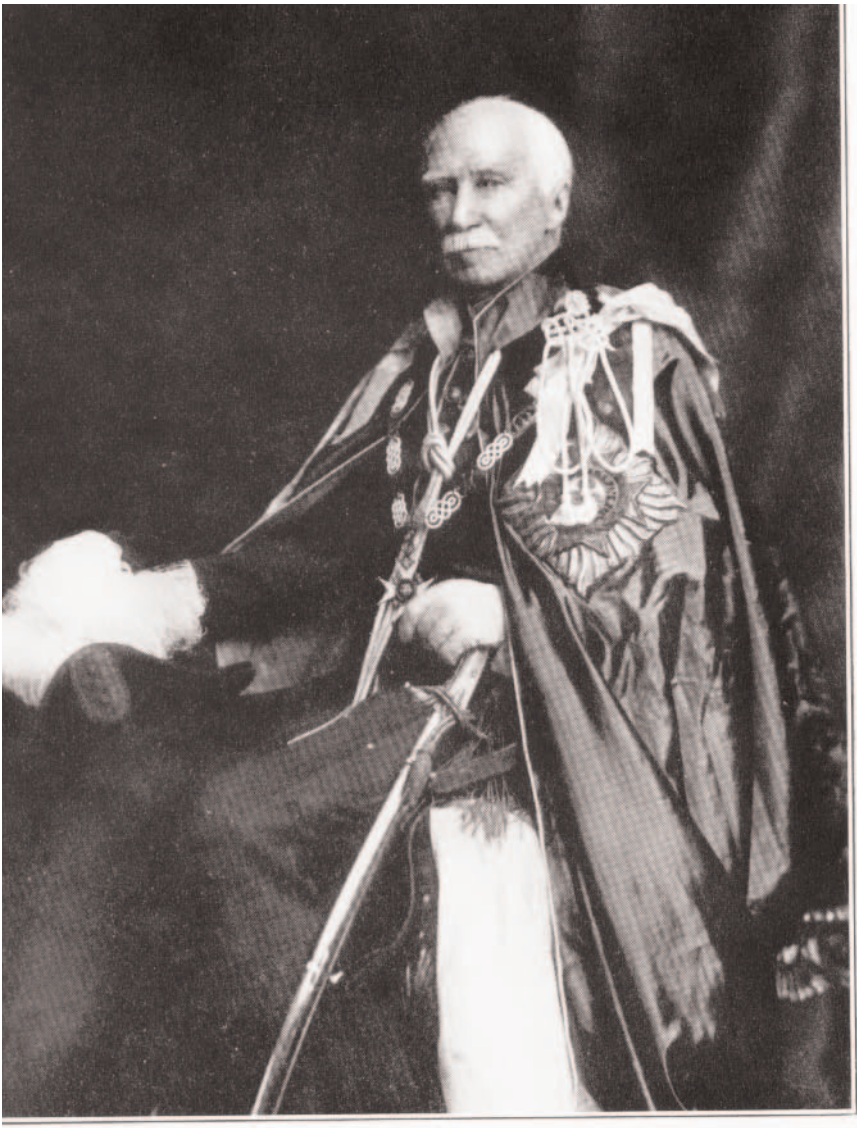


General Sir Bindon Blood, G.C.B., G.C.V.O.,
Colonel Commandant R.E.

General Sir Bindon Blood GCB GCVO

GENERAL SIR BINDON BLOOD, G.C.B., G.C.V.O., COLONEL COMMANDANT R.E.

By J.R.E.C. and S.H.S.

ON May 16th 1940, and within one month of the acceptance by H.M. The King of his resignation of the appointment of Chief Royal Engineer, Sir Bindon Blood, one of the most outstanding figures of the Royal Engineers and indeed of the whole British Army, passed over to his rest at the great age of 97.

Sir Bindon, who was born on November 7th, 1842, came of an old Irish family and was descended from Captain Edmund Blood of Mackney in Derbyshire, who settled in County Clare about the end of the sixteenth century. A grandson of Edmund was the famous Colonel Thomas Blood, who attempted to steal the Crown Jewels from the Tower of London in 1671. Sir Bindon's great-grandfather, in 1778, helped to raise and became Colonel of the Ennis Volunteers, a force which was raised for the suppression of riots and for the safety of the country. The colours of this battalion are still in the possession of the family. Sir Bindon was the eldest son of Mr. W. B. Blood, who was the head of the family and in 1841 married Miss Stewart. As a boy he was educated at the Royal School at Banagher in Kings County, and in 1859 he passed for a Cadetship at the R.M.A., Woolwich, but actually joined the Indian Military Seminary at Addiscombe. After a course lasting for one year he was commissioned in the Royal Engineers on December 19th 1860.

For the next ten years Bindon Blood was stationed mostly at Chatham and at Aldershot. A young R.E. officer's military education was then, apart from barrack-square drill, purely technical. The reason for this was that, at that time, no officers of Royal Engineers were employed as general officers in command or on the staff of the Army except in India. In his book, *Fourscore Years and Ten*, he relates some interesting events of that period. In 1865, he first met "Chinese Gordon," who had just returned from his successful campaign in China with his "Ever Victorious Army." In 1868, H.R.H. The Duke of Connaught honoured the Corps by starting his career as a commissioned officer in the Royal Engineers. At Chatham Lieut. Blood saw a man, who had been dismissed with ignominy, drummed out of the ranks, and he had, at Aldershot, to witness the unpleasant spectacle of a punishment of fifty lashes inflicted on a soldier. He was also at Aldershot when two officers of the 17th Lancers, who had been discussing Alken's famous coloured prints known

as "The First Steeple-chase on Record," challenged each other to a match to be ridden under similar conditions. This episode finished with a severe wigging for the officers concerned by H.R.H. The Duke of Cambridge, who was Colonel of the Regiment.

While taking a keen part in all pastimes and sports, the young officer worked hard and earnestly at his profession. At Chatham in 1867 he submitted a design for a new pattern of pontoon bridge which was approved and finally adopted in 1870. He was also entrusted with important work in connection with the organization of military telegraphs; and, when the R.E. Telegraph Troop was first formed in 1870, he was the first officer appointed to it. But his thoughts had turned continually to India. Having effected an exchange with a brother officer serving in the Bombay Presidency, he embarked for the East in March 1871 and thus started the distinguished Indian career which was to last, with intervals of active service in Zululand and South Africa and short spells in England, until October 1906.

In the autumn of 1871 Bindon Blood was posted to the Bengal Sappers and Miners at Roorkee which had been the headquarters of the Corps since 1854. Situated on the banks of the Ganges Canal, about 20 miles S.W. of Hurdwar, it was an ideal training ground. Sport, too, has always been good there and, in the 'seventies, tigers were numerous in the jungles within 20 miles, leopards sometimes came actually into cantonments, and duck and snipe abounded in the *Kadir* of the Ganges. To a subaltern keen on his profession, a good rider and a first-class shot with gun and rifle, life must have seemed ideal. A polo club was started at Roorkee in 1873; ponies then measured thirteen hands or under and could be bought for ten or fifteen pounds. Wild boar were abundant in the *Kadir* and pig-sticking became a popular form of sport, Bindon Blood being one of the hardest riders. Incidentally he broke a collar-bone and three ribs after a pig in 1874. He shot his first tiger near Roorkee and in later years increased the tale to over fifty.

He was promoted Captain in 1873 and the next few years were full of incident. In the winter of 1875 he had the honour of being introduced to H.R.H. The Prince of Wales during the Royal visit to India, and he was in command of a large detachment of the Bengal Sappers and Miners, which formed part of the Imperial Assemblage held at Delhi, when Her Majesty Queen Victoria was proclaimed Empress of India on January 1st, 1877. It was here that he first met Maharajah Sir Pertab Singh of Idar with whom he formed a life-long friendship.

It was not until his eighteenth year in the Army that he saw his first active service when he commanded two companies of Sappers and Miners which formed part of a punitive expedition against the Jowaki Afridis, a small tribe which inhabited a triangular area east

of the Kohat Pass. It was only a small affair but the medal which he earned for it was the first of the many war medals which he was destined to wear. His first tour of Indian service came to an end in August 1878 and he was posted to Chatham. His time in India had been full of work and sport but he had always found leisure for serious military study, and he realized from the first how supremely important it is to know your men. It was this characteristic which contributed so much to his success as a commander and he retained until the end this ability to earn, not only the respect and admiration, but also the affection of those who served under him, whatever their rank.

It was not long before Bindon Blood again saw active service, for the Zulu War broke out early in 1879. The campaign began most inauspiciously and the British troops under Lord Chelmsford met with a severe reverse at Isandhlwana on January 20th. By the end of April large reinforcements had arrived from England and Bindon Blood accompanied them in command of a field company. After spending some time at Durban he was appointed C.R.E. of the 1st Division: this formation took no part in the fighting, but remained at the mouth of the Tugela River for three months, where it suffered severely from sickness due to the very unhealthy nature of the country. Bindon Blood devotes four chapters of his book *Fourscore Years and Ten* to a description of this campaign and to constructive criticism of the numerous mistakes that were made in its prosecution. Considering the period which elapsed between the year of the Zulu War and the time when Sir Bindon wrote his book, one is struck not only by his amazing memory for detail but also by his critical faculty and his ability to point a moral. For his services in the Zulu campaign Captain Blood received a Brevet Majority. Hardly had he returned to England at the end of 1879 when he found orders awaiting him to join Sir Frederick Roberts' force at Kabul where he arrived in March 1880, that is, some seventeen months after the Second Afghan War had broken out.

Major Blood was unlucky in not taking part in any of the more spectacular phases of this campaign, but he found plenty of work for the R.E. under his command at Kabul. Following Wellington's example at Torres Vedras, he also found time to import a few couple of hounds from Peshawar with which he ran a drag-hunt. Meantime, events in Southern Afghanistan had shifted the centre of military operations from Kabul to Kandahar. As Northern Afghanistan was considered to have been pacified, Abd-ur-Rahman was placed on the throne at Kabul and was invested with full powers as Amir of Afghanistan. The British forces there, their task having been completed, were consequently ordered back from Kabul to India. Major Blood accordingly left Kabul with his two companies of Sappers

and Miners on August 7th, taking the Jelalabad route in company with a small column of all arms of which he took command; on reaching Peshawar, he picked up another two Sapper companies and eventually reached Roorkee in September 1880. Colonel E. T. Thackeray, V.C., was then Commandant of the Corps; but, during his absence on sick leave, Major Blood officiated in command, and was soon hard at work on the reorganization of the Bengal Sappers and Miners in friendly consultation with the other two Corps in Madras and Bombay.

In the spring of 1882 he left India for England and was posted to the 26th Field Company at Shorncliffe. It was not long, however, before he was again on active service. The events leading up to the campaign in Egypt in 1882, interesting as they were, would take too long to record in this memoir. It is sufficient to say that economies introduced by the Khedive Tewfik, involving a reduction of the Egyptian Army, had led to a mutiny which was headed by Arabi Pasha. There followed riots and massacres in Alexandria and the British Government decided to intervene with a view to restoring order in Egypt. The campaign opened with the bombardment of Alexandria by the British Fleet on July 11th 1882, and on July 24th an expeditionary force of 21,000 men of all arms, under the command of Sir Garnet Wolseley, was mobilized for despatch to Egypt. The 26th Field Company, commanded by Major Blood, was attached to the 2nd Division of this force and served most of the time with the 3rd Brigade under Sir A. Alison.

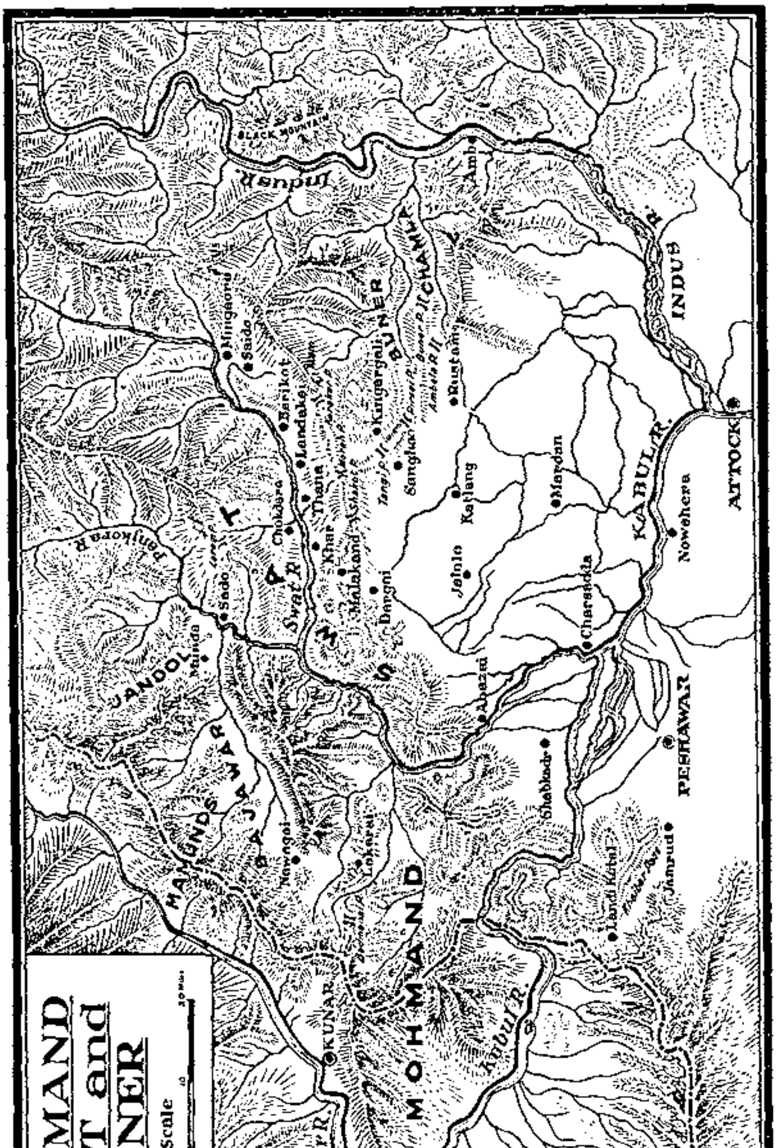
On landing at Alexandria on August 15th, Sir Garnet Wolseley realized that an immediate advance from that place on Cairo was impracticable, owing to Arabi's strong position at Kafr Dawar, ten miles east of Alexandria; he therefore moved his force and his base of operations to Ismailia. Pushing forward thence along the Sweet-water Canal he occupied Kassassin on August 26th. Arabi then fell back on his Tel-el-Kebir entrenchments, where he had a force of about 25,000 men and 60 guns. The British force attacked Tel-el-Kebir with complete success at daylight on September 13th. In this battle Major Blood's Sappers were with the infantry reserve. After the action, in which it took an active part, the 26th Company was sent to Benka, 30 miles west of Tel-el-Kebir, where a force was formed to deal with any enemy move from Kafr Dawar. The Egyptians there surrendered shortly afterwards and Major Blood and his Company were sent to Cairo, where they stayed, doing useful work, until he was transferred to England in May 1883. For his services in this campaign Major Blood was promoted Brevet Lieutenant-Colonel.

On the 12th July 1883, Lieut.-Colonel Blood married Miss Charlotte Colvin, daughter of Sir Auckland Colvin of the Indian Civil Service, an ideally happy partnership which remained unbroken for 57 years.

Lieut.-Colonel Blood's thoughts now turned again to India; and in 1885 he became Commandant of the Bengal Sappers and Miners at Roorkee, an appointment which he held for the next seven years. During this time he put the finishing touches to the reorganization of the Corps and, aided by a picked band of officers—Aylmer, Barton, Leach, Buston, Heath, Bond, among others—he brought the Bengal Sappers to a high standard of efficiency. *Mens sana in corpore sano* was his watchword and a judicious mixture of work and sport made life very pleasant for the British officers and other ranks under his command. The Indian ranks idolized him as one who knew and understood them, and whom they recognized as a fine soldier, a slayer of tigers and a thorough sportsman. His popularity was shared to the full by his wife, who contributed in no small measure to the success of the various commands which he exercised. The outstanding service which he had rendered whilst in command of the Bengal Sappers and Miners was recognized many years later by his being appointed their Colonel in March 1918, in succession to General Sir Edward T. Thackeray, V.C., K.C.B.

In 1894 he was appointed Colonel on the Staff at Rawalpindi and in March of the following year he became Chief Staff Officer to Major-General Sir Robert Low, who had been appointed to command the Chitral Relief Force. Colonel Blood's selection for this important field service appointment was a singular proof of the high esteem in which his military qualities were held at the time. Chitral was a small hill state at the head of the Kunar Valley, situated about 140 miles north of Nowshera, which became the base of operations of the Relief Force. Its ruler, the Mehtar Sher Afzal, aided by a freebooter named Umra Khan, had laid siege to a fort near Chitral village which was garrisoned by Indian troops under the command of a few British officers. The Relief Force had been organized to invade Chitral and relieve the besieged garrison.

The first obstacle to be surmounted was the Malakand Pass, 40 miles north of Nowshera, which was strongly held by Umra Khan's tribesmen, the forcing of which seemed likely to prove to be a difficult task. But the dispositions made for its attack, which included close support by mountain artillery, were so successful that the Pass was carried, after a six-hour fight, on April 3rd 1895. A great piece of luck was the discovery of an old Buddhist road over the Pass, which was quickly put in order by the Sappers and expedited the passage of the Force over the Pass. During the subsequent advance the Swat and Panjkora rivers, snow-fed and unfordable, were bridged, the former by Major Barton and the latter by Major Aylmer, who had won the Victoria Cross at Nilt in 1891. On April 17th an advance was made to Munda, where Umra Khan had some 9,000 of his best men. He, however, put up a very poor fight and disappeared into Afghanistan where he died shortly


MOHMAND
SWAT and
BUNER
Scale
PESHAWAR
ATTOCK
Nowshera
JALALABAD
KUNAR

afterwards. All opposition now ceased and the advance continued; but meanwhile Chitral Fort had been relieved by a small force under Colonel Kelly which had made a gallant and adventurous march from Gilgit over the Shandur Pass.

The Chitral campaign was essentially a "Sappers' War." Luckily the Force was strong in technical troops, and Colonel Blood was the very man to get full value out of them. He received the K.C.B. for his valuable services as Chief Staff officer and his investiture took place at Windsor Castle on April 1896, when Her Majesty Queen Victoria conferred the honour of knighthood upon him. On that occasion he presented to Her Majesty an ancient manuscript copy of the Koran.

Meanwhile, Colonel Blood had been given command of the Bandelkand Brigade, with headquarters at Agra; but he only held it for a year or so, being destined for greater things than the command of a 2nd-Class District. Trouble had been brewing for some time on the North-West Frontier, and the spark which lit the flame was a treacherous attack by Wazirs on a Political Officer and his escort at Maizar at the head of the Tochi Valley. The mullahs preached a *Jehad*,* and Wazirs, Swatis, Mohmands, Afridis and Orakzais all answered the call; in a short time the whole frontier was ablaze.

The Swat Valley was a special centre of religious fanaticism, and on July 26th fierce attacks were delivered by the tribesmen on the Malakand camp and on Chakdarra Fort, both of which were repulsed. Reinforcements were sent up and Sir Bindon Blood was given command of the Malakand Field Force with the temporary rank of Major-General. It was the most important command held by a Royal Engineer officer in India since the days of the Mutiny. Sir Bindon had the *Shikarri's* eye for country, and the careful notes which he had made of the terrain during the Chitral expedition now stood him in good stead. He arrived on August 1st and, after a brisk fight, relieved Chakdarra the next day.

A complete division was assembled in the course of the next few days and, by the middle of August, Sir Bindon had advanced up the Swat River and was facing "The Gate of Swat" at Landakai, considered by the tribesmen to be impregnable. This action was concisely described by Winston Churchill in *The Story of the Malakand Field Force*. "The principle of concentrating artillery has been admitted in Europe, but Sir Bindon Blood is the first General who has applied it to mountain warfare in India. At Landakai the Force had eighteen guns in action, of which twelve were in one line. The fire of this artillery drove the enemy, who were in great strength and in an excellent position, from their ground, and the infantry attack was accomplished with hardly any loss." The Swatis soon came to terms.

* Holy War.

The next operation was an advance westwards into Bajawar against the Mamund section of the Mohmand tribe, with which Major-General E. R. Elles co-operated with a force of two brigades from Peshawar and Shabkadr. By September 14th, Sir Bindon was in Nawagai with his 3rd Brigade, the 2nd Brigade being to the east of him. Determined night attacks were made on Nawagai on September 19th and 20th, but were repulsed with heavy loss to the enemy. On the 21st he joined hands with Major-General Elles and, leaving the Mohmands to the latter, Sir Bindon proceeded to clear up the Mamund situation, which he did so speedily that the operations of the Malakand Field Force came to an end by the middle of October. He had, as extra *A.D.C.* during part of these operations, Lieutenant Winston Churchill, of the 4th Queen's Own Hussars.

The Bunerwals alone remained defiant. They boasted that their country had never been invaded since the days of Alexander, and recollections of the fighting at the Ambeyla Pass in 1863 had not entirely faded. They were good fighters and the natural difficulties of the country were considerable; but, so sound were Sir Bindon's plans and so well were they carried into effect by troops who thoroughly trusted their commander, that the campaign only lasted a fortnight and the Buner Field Force was broken up on January 21st 1898.

The record of these few months of fighting, resulting in one successful operation after another, constitutes a tribute of no mean order to the soldierly qualities and capacity for command of the General who conducted them. For his services in these operations he was, in May 1898, promoted Major-General for distinguished service in the field.

It was not until April 1898 that the Afridis finally submitted and, as this brought an end to the most extended rising that had until then ever been experienced on the North-West Frontier, there followed ten years of comparative peace. The Army in India had thus an opportunity for settling down to regular and systematic peace training, of which Sir Bindon, who had meantime been appointed to command the Meerut Division with 11,000 troops under him, took the fullest advantage.

In April 1898 he had taken short leave home and was honoured by an invitation to Osborne House where H.M. Queen Victoria showed great interest in his account of the late expedition on the North-West Frontier. He was also received more than once by H.R.H. The Prince of Wales.

For the next two years Sir Bindon continued to command the Meerut Division. Being stationed in one of the most sporting areas of India, he took full advantage of his opportunities and added considerably to his bag of tigers. But in January 1901 he was ordered to South Africa, together with other general and staff officers from

India, in compliance with a request from Lord Kitchener who had recently succeeded to the supreme command in South Africa. On arrival at Pretoria he was appointed local Lieutenant-General and was given command of the Eastern Transvaal, where some 35,000 of our troops were operating, with headquarters at Middelburg. One of his first tasks was to stop the Boers from their favourite pastime of raiding the railway, which he succeeded in doing by a combination of stratagem and blockhouse lines.

For the next five or six months he controlled operations involving the driving of various areas with several columns, always with the object of rounding up some particular Boer commando and its commander. Reading between the lines of the chapter of his book which he devotes to this period, it is apparent that he was not too well served by some of his subordinates, whilst he makes some very trenchant remarks about the slack and unsoldierlike methods of certain individuals. He returned to India in October 1901.

Before embarking for South Africa, Sir Bindon had been offered his choice between the Military Membership of the Viceroy's Council in India and the Punjab Command. He unhesitatingly chose the latter; it was the most important military command in India and included in its area the North-West Frontier. He took over command in October 1901.

In the chapter of his book which deals with his experiences in the Punjab Command, Sir Bindon tells us but little of the extensive military reforms which were instituted by Lord Kitchener, who had become Commander-in-Chief in India in November 1902. One is inclined to ask whether he was ever consulted in this important matter, as he would hardly have omitted to say so had his opinions indeed been asked for. He tells us, however, that he was liberally treated in the matter of training grants for manœuvres, so that one may be sure that the troops under his command, numbering some 85,000 men, must have benefited from the experience of serving under a General who had so often and indeed so recently proved his worth in the field. During the winter of 1904–05, when Their Majesties King George and Queen Mary (then Prince and Princess of Wales) spent about a month in the Punjab Command, Sir Bindon directed manœuvres by more than 60,000 men, the greater part of whom took part in a ceremonial parade and marched past Their Royal Highnesses in full dress on the day after the manœuvres terminated. The staff work involved in getting the troops on to the parade ground—practically straight from their manœuvre camps—was a performance of which their Commander-in-Chief was very justly proud.

Another incident to which Sir Bindon alludes was the now forgotten 9th Lancer case. This distinguished regiment had been most unjustly accused of shielding the perpetrators of an assault on an Indian

menial, which led to the latter's death. The matter had been carried up to Viceregal level and the Regiment was subjected to the most unjustifiable official obloquy. Sir Bindon championed their cause to his utmost but only received an official rebuff for his pains. This incident is quoted to show how, as always, his first thoughts were for the welfare and, if necessary, the vindication of the men who served under him.

The period of his service on the active list was now rapidly drawing to a close, and what he calls the " melancholy day " arrived at last on November 7th 1907 when he eventually retired after close on forty-seven years of continuous and distinguished service. For his services in the field Sir Bindon was mentioned in despatches no less than eight times. He had earned seven war medals with several clasps, as well as the Order of the Osmanieh for his services in the Egyptian campaign of 1882. He also received the K.C.B., two brevet promotions and one substantive promotion for distinguished service in the field.

Sir Bindon settled in England and in 1909 was created a G.C.B. In July 1914 he was appointed a Colonel Commandant. Three years later he became Representative Colonel Commandant and he continued to represent the Corps for the next sixteen years. During all this long period, and in spite of his advancing years, which, however, seemed to pass him over without leaving their mark, he maintained the liveliest interest in the activities and welfare of the Corps which he loved so well. There were very few Regimental functions which he did not attend, and those who were privileged to listen to the addresses which he was accustomed to give to the troops and veterans at the Annual Veterans' Parade at Chatham never failed to be stirred by the simple yet compelling words in which he used to convey to us the all-important duty of loyal service to the Corps of Royal Engineers.

In 1932 H.M. The King created him a G.C.V.O., in acknowledgment of the eminent services he had rendered to the State and to his Corps. Shortly after he had celebrated his 90th birthday in the same year he was entertained by the Corps at the Headquarters Mess at Chatham. The Mess Room was filled to capacity with officers of the Corps and, as it was a family gathering in the best sense of the word, there were no guests from other regiments present on that occasion. No one who was present will ever forget the spectacle of our beloved Chief standing up with all the outward vigour of a much younger man to respond to the toast of his health or the simple, yet heartfelt, words in which he thanked his brother officers for the honour they had done him.

In the following year Sir Bindon relinquished the post of Representative Colonel Commandant, the duties of which he had filled so conscientiously and with such outstanding success for the preceding

sixteen years. Yet he still found time to attend Corps functions and, when his great age began to take its toll of his energies, he was never so happy as when he was discussing Corps matters with his brother Colonels Commandant in his own home.

In October 1936, when the post of Chief Royal Engineer was re-created, H.M. The King selected Sir Bindon to be the first to fill this honourable appointment: it goes without saying that His Majesty's selection met with the universal approbation of his brother Sappers. As the years passed by his great age began to make itself more and more felt, and he found himself less able to maintain his active interest in Corps matters. Nevertheless he was always ready with his charming smile of welcome for any brother officer who came to consult him or to give him news of the Corps. He began to realize, however, that his race was nearly run, and that he was approaching the winning post to receive the reward that comes to all who, like him, have fought the battle of life gallantly, who have set to their fellow-men an example of how life should be lived, and who have placed service to King and Country ahead of self-interest. The end, though not unexpected, came very suddenly and left all of us who knew him, who honoured him and who loved him, with a sense of personal bereavement akin to that felt at the loss of one's nearest and dearest relative.

For over fifty years Lady Blood had shared in his difficulties and in his triumphs. They were an ideally happy couple and she backed him up, as only a devoted wife can, in his every effort to work for the good of the Corps. To her the Corps of Royal Engineers offers their heartfelt sympathy.

The Corps has lost a very great Sapper and the Nation is the poorer through the passing away of a very great gentleman.

CENTRAL HEATING OF QUETTA MILITARY HOSPITALS.

By CAPTAIN H. E. WILLIAMS, M.B.E., R.E.

WHEN the Quetta Reconstruction Committee had formulated the general outline of the rebuilding scheme, the question arose as to the method to be adopted for heating and domestic hot water services in the combined British, Indian and Families' Hospitals which formed part of the reconstruction programme.

Fuel is expensive at Quetta. Local coal is available from mines in the mountains about 20 miles out of Quetta, but the demand is not sufficient to make coal-mining commercially worth while. As a result all coal is imported by rail, which involves a transport charge of practically 80 per cent of the pit-head cost. Coke is more expensive than coal. The approximate costs are : coal Rs. 18 and coke Rs. 28 per ton delivered.

The possibility of utilizing electrical energy was discounted by the fact that the generating station is a private concern with whom the Army Department has an agreement which does not lapse for some years. Fortunately for this Company, the earthquake did not seriously affect the power station and they were able to generate, but not supply, owing to the overhead supply lines being down in most areas.

The cost of electric energy at Quetta is 1 anna 11 pies per unit, which alone would preclude its use for general heating, apart from the fact that the present plant would not have been sufficient to meet the load of the heating demand as well as the existing load. Any extra plant would, of course, reflect on the cost of current.

With these facts in view a decision was arrived at to instal a central heating plant and system for the hospitals, using coal as a fuel.

The buildings to be heated consisted of the following :—

In the Indian Troops' Hospital—

9 General ward blocks.
1 Venereal ward block.
1 Officers' ward block.
1 Operating theatre.
1 Administration block.
1 Store block.
3 Kitchen and dining-room blocks.
1 Clinical side room.

In the British Troops' Hospital—
5 General ward blocks.
1 Venereal ward block.
1 Officers' ward block.
1 Operating theatre.
1 Administration block.
1 Store block.
1 Kitchen and dining-room block.
1 Clinical side room.

The Families' Hospital with 25 beds and maternity wing—
1 Specialists' block.
Steam laundry and disinfector block. (See Fig. 1.)

The first proposal contemplated independent boilers in duplicate in each ward block. This was dropped on account of high first cost and difficulty of control, as well as smoke and ash disposal difficulties.

The possibility of using steam heating was considered, but owing to it being almost impossible to arrange the control of temperature from a central point it was abandoned. The problem of condensate return also presented some difficulty.

Next it was suggested that steam-water calorifiers arranged at each block should be adopted. This would entail separate accelerators at each block for the heating system and would still not allow centralized control, besides making for a multiplicity of plant.

It was, therefore, decided to use accelerated hot water as the means of conveying the heat and to provide a central boiler plant, sited at some distance from the hospital to avoid smoke and dust from fuelling and ash disposal.

The plant decided upon consists of boilers with auxiliaries, non-storage calorifier and accelerator systems, for the general heating, storage calorifiers, with accelerated system, for the domestic hot water services, and H.P. steam and condensate services to serve the laundry, kitchen, disinfector and operating theatres.

The question was further complicated by the conditions of the occupation of the hospital. In peace and under normal conditions the hospital will be about 30 per cent occupied. This, however, does not necessarily mean that 70 per cent of the buildings will be unoccupied. On the contrary it is possible that, owing to patients suffering from various complaints or injuries, all the wards may be occupied, with perhaps only one or two persons in some of the wards. Under these conditions it became necessary to provide for practically just as much heating when the hospital is partially full as when it is crowded ; as a matter of fact, it would actually require more heat, to the extent of the body heat of the number of persons required to fill the hospital up to strength. It was recognized that large losses from mains would result with regard to the numbers for whom

heating is being provided when the hospital is sparsely occupied, but this would be discounted when using a central plant by the higher efficiency and superior control possible with a centralized plant.

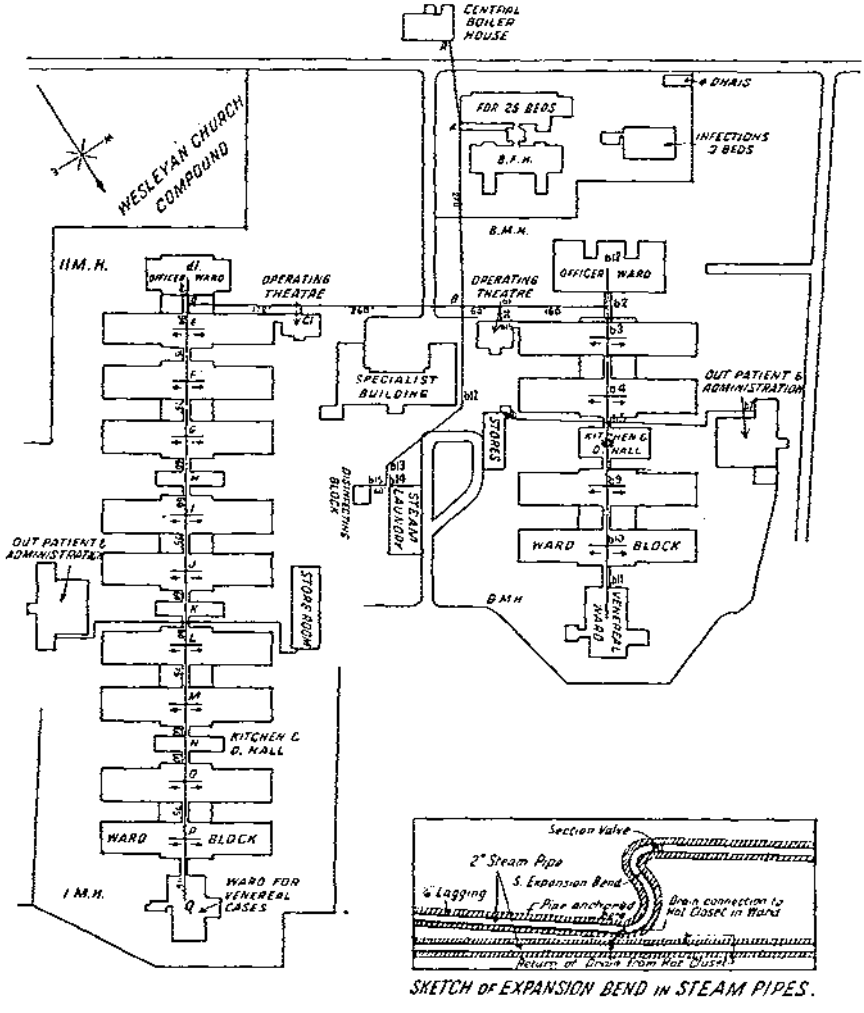


FIG. 1.

In view of the buildings being constructed to resist seismic shock, construction methods precluded the use of trenches beneath the buildings. Further, in view of the wide range of temperatures which occur at Quetta, special attention to the insulating properties of roof and walls had to be given, which, besides giving good results from the thermal resistance standpoint, were reasonably cheap, light and suitable to the general form of construction being adopted.

The walls were constructed of double Hy-rib panels, 4 in. apart, filled with a mixture of $\frac{3}{4}$-in. gauge broken brick cellular cement concrete of a density of about 97 lb. per cu. ft., which, when poured in, formed a cellular panel. The outer faces of the walls are rendered with 1 in. thick cement plaster. Much doubt as to the thermal transfer of this wall arose. Taking an arbitrary figure for this brick concrete filling and known values for the plastering, the B.T.U.'s, per sq. ft., per degree difference of temperature, was ·143 B.T.U.'s. This figure was much doubted and, in order to decide the issue, a 2 ft. box of $\frac{1}{2}$-in. Celotex (the characteristics of which were known) was made, and within it were arranged eight 40-watt lamps connected through a calibrated electricity meter to the electric main. Thermometers were arranged through the walls of the box and the whole mounted on wooden knife-edges on a stand and erected in a closed room clear of all draughts. The external temperature about the box within the room was taken at the level of the top and bottom, and midway between these levels, and also 4 ft. away, so as not to be seriously influenced by any radiation or convection air currents from the box. Current was switched on and, after four days, the conditions within and without of the box appeared to have reached a steady state. Using the formula $3{\cdot}412W = AK(t_1 - t_0)$

where W = watts input,
A = area of box in sq. ft.,
K = transmission coefficient or B.T.U.'s per sq. ft. per degree difference of temperature per hour.
t_1 = inside temperature (average),
t_0 = outside temperature (average),

it was found as a mean from three tests that the result obtained corresponded almost exactly with the results quoted by the makers of the Celotex.

A " purpose made " slab of the wall was then made just to fit over the end of the box and was secured thereto by asbestos cord. Care was taken to avoid all infiltration or exit of air from leaks and the current was again switched on until steady state conditions were reached. This took nearly fourteen days, due to the moisture in the wall.

Modifying the formula to read :

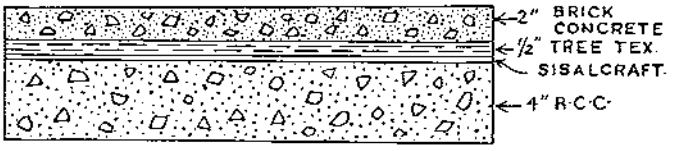
$$(A - A_1)\,K(t_1 - t_0) + A_1K_1(t_1 - t_0) = 3{\cdot}412W$$

Where K = coefficient for new material to be tested and A_1 is the new area of the box and, allowing for the extra exposed area due to the 6 in. thickness of the slab, the rate of heat transference was found to be ·266 B.T.U.'s, per sq. ft., per degree, difference of temperature.

This is considerably more than the original figure, but for a 6 in.

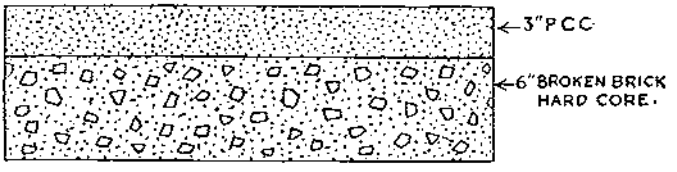
wall is a very good figure, a normal 6-in. concrete wall being ·48 B.T.U.'s per sq. ft. per degree per hour.

The roof was constructed as shown below :—



The coefficient adopted being ·267 B.T.U.'s sq. ft.

And the floor as below :—



The coefficient adopted being ·14 B.T.U.'s sq. ft.

To take up for orientation 10 per cent was allowed on north walls and also 10 per cent on the roof to counteract the effect of the Kojat wind, which is a very cold, high wind, blowing down the Quetta valley.

The under-floor temperature was taken as 40°F.

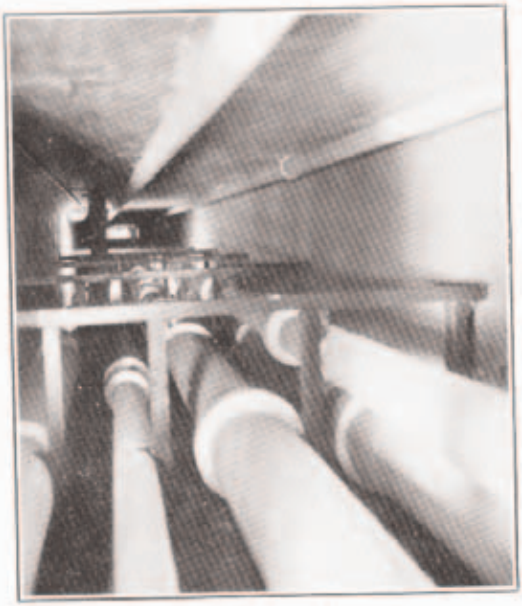
In general wards two air changes were allowed per hour.

The temperature to be maintained was 60° internal with 30° outside.

The first proposals were to utilize panel Rayrads in ceilings. This was abandoned owing to their weight and difficulties of accommodating pipes, neither of which could be easily catered for in the earthquake-resisting construction of the building.

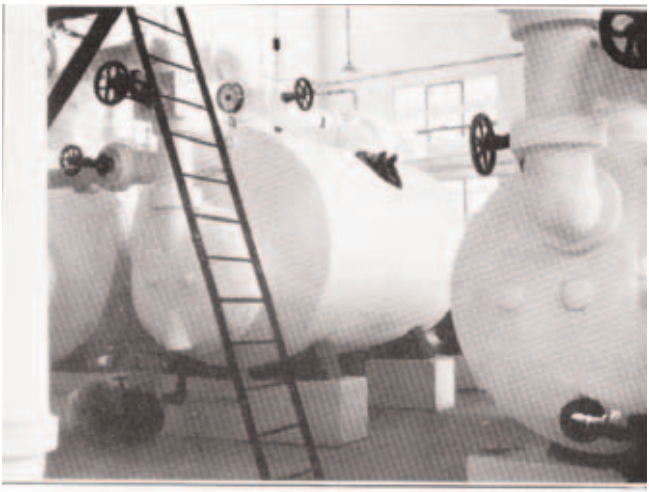
As regards pipes, between the boiler house and the points where they entered the buildings they were carried in trenches which were arranged sufficiently remote from the building foundations to obviate any collapse from seismic shock. But it was considered desirable not to allow trenches beneath buildings and, in order to provide a suitable duct to carry heating, domestic hot water, cold water, steam and condense mains, a false ceiling was arranged for in the corridors throughout the hospital blocks to accommodate them. This, of course, meant that both flow and return heating mains were about 11 ft. above ward floor level. In order to ensure good circulation a single pipe loop system was decided on for all wards and rooms in the buildings, and, in order to get an equable temperature, No. 24 type Ideal Rayrads were adopted. This type of radiator is partly a low-temperature radiant heater and a convection air current heater. Tongue tees are provided for on the inlet side connection to

1.—Typical Ward

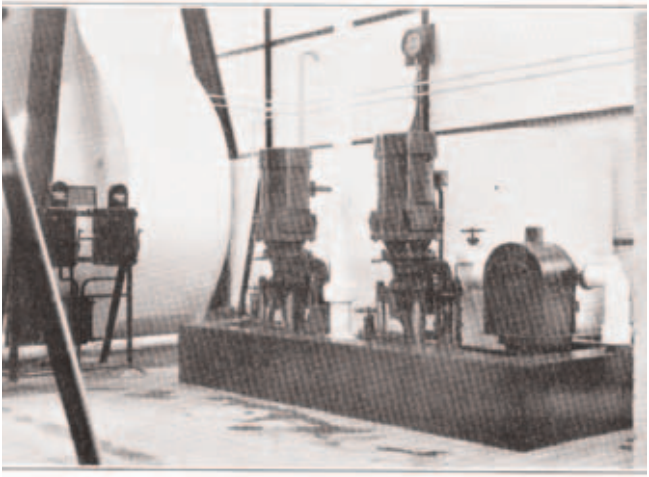


2.—Pipe Duct over Corridor

Central heating of Quetta military hospitals 1 & 2



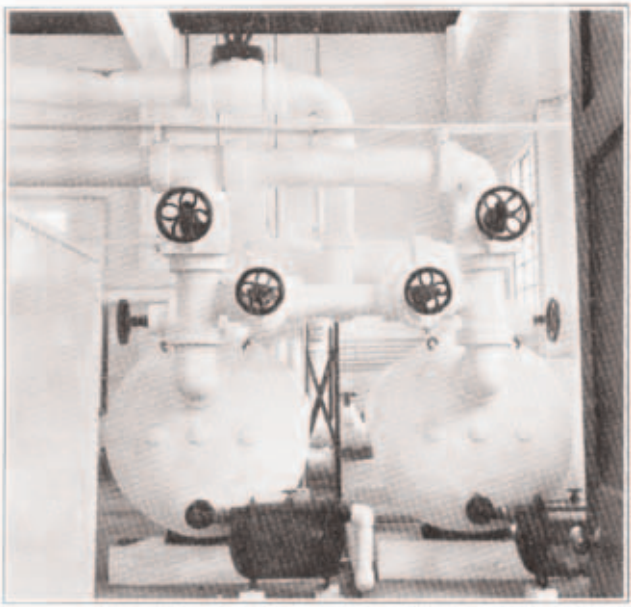
3.—Calorifiers.



4.—Feed Pumps and Induced Draught Fan.

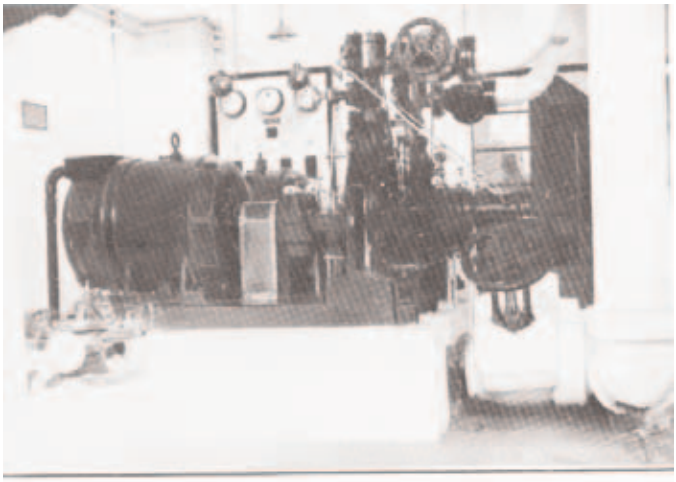
Central heating of Quetta military hospitals 3 & 4

5.—Domestic H.W. Accelerator Pumps.

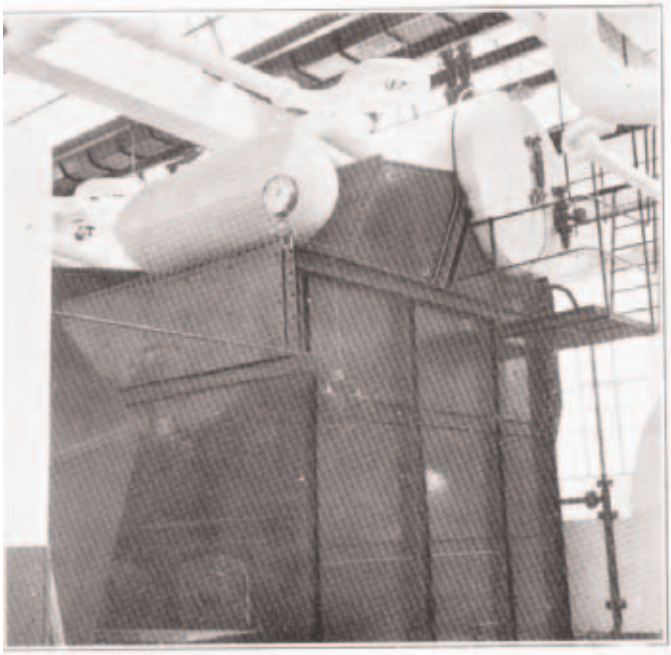


6.—Domestic Hot Water Calorifiers.

Central heating of Quetta military hospitals 5 & 6



7.—50 K.W. Turbo Generators.



8.—No. 1. Boiler.

Central heating of Quetta military hospitals 7 & 8

assist circulation, and each radiator had a single concealed regulating valve and also an air cock. It will be evident that since the radiator on the hottest part of the pipe loop (incoming side) will assist the radiator on the opposite side of the ward, where the water is coldest, by the influence of its radiated heat, the net effect throughout the room will be one of even temperature. A sheet steel shelf was provided over these radiators to deflect the rising convection currents towards the centre of the room and to form a cover to prevent anything being dropped behind the radiators.

In the passages, New Classic Wall type radiators were adopted.

In sanitary annexes and in stores, in order to keep heating surfaces above floor level, a gilled steel tube loop was arranged over all cubicles, 18 in. below ceiling level.

Throughout the wards a 2 in. loop was arranged in order to keep uniformity and give sufficient strength to prevent bending, should any person stand upon them. Actually, a 2-in. pipe was the size necessary at the ward farthest from the boiler room for the lowest circulating differential pressure. Wards nearest the boiler room could have got proper heating if 1¼-in. pipe had been used, owing to the large differential pressure between the flow and return main at that point.

Operating theatres are provided with sufficient Rayrad heaters to cope with the building losses only, with 30° outside and 75° inside, no air change being taken up for. The whole of the ventilation was treated by an air conditioning plant which is under automatic control, with press-button stopping and starting gear, and can be worked by the occupants of the theatre. The air conditioning equipment was designed so as to be capable of maintaining in each operating theatre the following conditions :—

Six changes of air per hour and any desired temperature between 70° and 85°F., with external temperature of 30°F., whilst the relation of humidity is variable between 55 and 65 per cent.

In the anæsthetic room four changes were specified and a temperature of 65°F., with a relative humidity between 55 and 65 per cent.

The gradual temperature change from ward temperature of 60°, through 65°F. in the anæsthetic room, up to the operating theatre temperature is especialy worthy of notice.

For each building the radiators and pipe runs were shown in different colours on the plan, and to make the exact position of pipes and radiators measurable as regards height, etc., the isometrics for each block were also drawn.

On each plan the positions of sleeve locations were tabulated so that the builder could pre-cast a 3–in. mean diameter wooden plug in each of these positions and, later on, the pipe fitter could take out the wooden plug, insert a sleeve and grout up.

Steam services for the laundry and disinfector blocks, air conditioning, sterilizing apparatus in each operating theatre and Families' Hospital and steam-cooking plant in the kitchen of the British Troops' Hospital, had to be provided for, and as far as possible all condensate returned to the hot well at the boiler room arranged. The anticipated demand at the laundry was 2,050 lb. per hour at 100 lb. sq. in. The total for the whole hospitals 3,200 lb. per hour.

Domestic hot water at not less than 140°F. at every draw-off point was taken up for. The maximum demand of the whole hospital was calculated at 5,660 gallons per hour, at an average temperature of 145°F.

The opportunity was taken also to utilize the heating pipe ducts for the housing of the cold water main passing to the distribution services within the whole of the hospital buildings.

SITE AND FIXED LOCAL CONDITIONS.

The site of the hospitals is on a sloping piece of ground, having a fall in the longest length, which measured between the place where the boiler room is located, to the farthermost building is 1,700 ft.

The local water supply is available at the boiler room site at a pressure of 75 ft. head.

The altitude is approximately 5,000 ft.

Maximum recorded shade temperature 112°F.

Minimum recorded shade temperature 10°F.

Normal duration of heating season—six months.

Calculations for Pipe Sizing.—The possibility of using high-pressure steam to work a turbo generator for developing electric power to operate auxiliaries in the boiler house and accelerator pumps and exhaust the steam from the generating sets into the calorifiers permitted all considerations of running cost of accelerator pumps to be practically neglected. This, therefore, made it possible to adopt as high a circulating differential as desired. On the other hand the higher the differential, the greater the flow velocity, and since any noise from water flow was to be avoided, a reasonable flow velocity of between approximately 2 to 3 ft. per second was adopted. The calculations were worked out in conjunction with the key plans and the tabulation of the results followed normal practice.

Steam pipes were determined on a flow velocity of about 6,000 ft. per minute.

The table used for this purpose is given in Fig. 2 and may be found useful for general purposes. The method of use is explained thereon, and it will be found to save considerable calculations.

The heating load is slightly in excess of the actual load, as initially the load had taken into account two glazed verandahs, one each of I.M.H. and B.M.H. troops wards, and also the connecting passages in

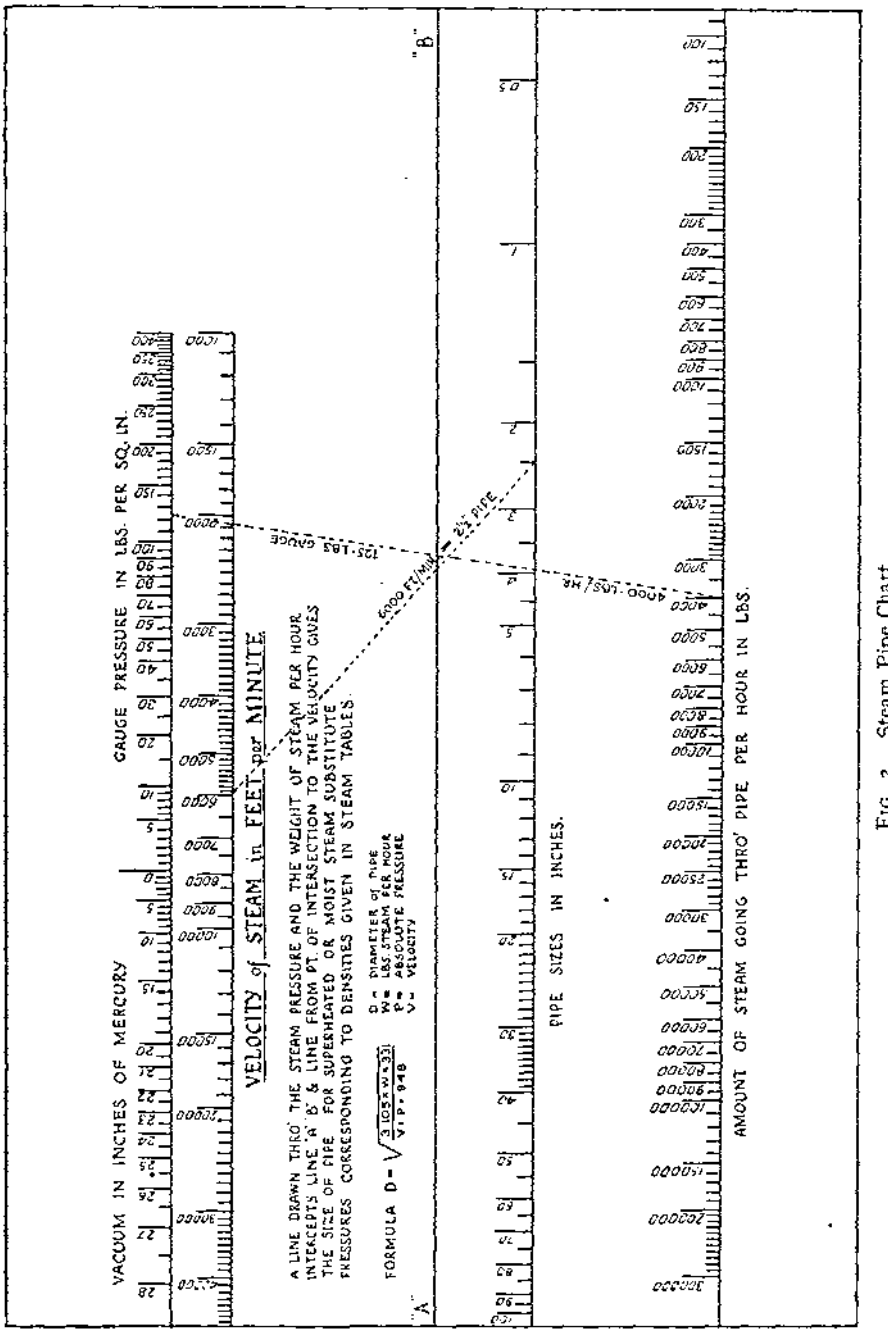


FIG. 2. Steam Pipe Chart.

I.M.H. and B.M.H. hospitals. However, this allows for future extensions if there are any.

CENTRAL PLANT AND BOILER HOUSE.

It is of interest to note that the possibility of generating electric power and supplying the local power company at their bus bars at a slightly cheaper rate than they themselves can do was worked out. It was demonstrated that it was quite practical to do this, making a small margin of profit after meeting all charges of fuel, labour, interest and depreciation charges at 6 per cent and 10 per cent respectively. The plant proposed was to be three 10,000 lb. per hour high-pressure boilers and reducing pressure pass-out turbine generator sets with the usual auxiliaries. Unfortunately the local company were not prepared to accept the offer, but had they done so, the cost of central heating the hospitals and for domestic hot water and steam would have been reduced to a negligible sum.

The plant to be installed under the present conditions, consists of :—

Three steam boilers, each 7,000 lbs. of water evaporated per hour from and at 212°F. at 160 lb. sq. in., blowing off pressure under normal conditions but capable of 8,000 lb. evaporation if forced. Each boiler is of the water-tube type made by Fraser and Fraser, and is arranged to be fired by an automatic under-fed stoker under pressure-stat control from the boiler pressure. The flue gases are dealt with by an electrically-driven fan. Induced draught is essential, since the chimney height is not to exceed 27 ft. 6 in., partly on account of appearance and principally because of precautions against earthquake shock.

The variable speed fan will be capable of producing a depression of $\frac{1}{2}$-in. water gauge at boiler outlets when two boilers are working at full output. This will permit combustion under approximately balanced draught conditions.

Two impulse-type steam turbine generator sets of 40 K.W. each are provided, either of which will produce sufficient energy to operate all auxiliaries in the plant room and boiler room. Lighting from these plants is not permitted under term of the agreement with the local power company. The exhaust steam from the generating sets is conducted to the calorifiers, but in case of the steam not being taken for this purpose, an automatic atmospheric relief valve is provided having an exhaust to atmosphere above the roof.

Heating Calorifiers.—These are of the non-storage type and are in duplicate, so arranged that normally one will take exhaust steam from the turbo-generators and the other live steam from the boilers, which latter steam will be varied so as to automatically maintain the desired flow temperature, which can be readily adjusted to suit

the prevailing outside conditions to keep the general internal temperature at some definite level, *i.e.*, 60°F.

The adjustment is effected by the moving of a weight along a lever, which works in conjunction with the spring loading of the thermostatic control valve.

The heating capacity of each of the calorifiers is 10,800,000 B.T.U.'s at 50 lb. sq. in., so that in emergency one calorifier with steam pressure at 50 lb. sq. in. would be sufficient to meet the whole demand of B.T.U.'s per hour, from water at 170°F. to 200°F.

The complete heating element is capable of being removed for cleaning purposes.

Two accelerator pumps are provided, one complementary to the other, and each is capable of pumping 36,000 gallons per hour against a head of 40 ft. Speed variation on the motors is provided, so that the circulating head can be adjusted.

Domestic Hot Water Calorifiers.—These are of the normal storage type with removable heating elements, each of 1,000 gallons capacity, capable of heating 5,000 gallons per hour from 50°F. to 150°F. when supplied with steam at 5 lb. sq. in. These calorifiers have only single heating elements. Normally one calorifier will use exhaust steam and the other steam at 50 lb. They are arranged in the system similarly to the heating calorifiers, the thermostatic control operating on the 50 lb. sq. in. supply only. In this case fixed temperature thermostatic control only is used.

Domestic accelerator pumps in duplicate are provided, each capable of circulating 5,000 gallons per hour against a differential head of 20 ft.

Boiler Feed Pumps.—These are electrically-driven Wier pumps, each delivering normally 16,000 lb. of water per hour against a boiler pressure of 160 lb. sq. in. gauge. No speed variation arrangements are provided, but owing to the fact that the power to drive these pumps is derived from turbo-generating sets, the exhaust from which is used for heating, it is arranged that the pump in use will work practically continuously so as not to affect the load on the generator sets. To this end spring-loaded relief valves are provided on the pump discharge, set to lift at 165 lb. sq. in., so that even if the boiler feed check valves are closed the pump can run on with little increase of load to its motor.

Generating Sets and Switchboard.—Owing to the high price of electric energy from the local supply company, it was obviously more economical to generate current by steam, using exhaust steam for heating. Two 40 K.W. sets are provided, but not arranged to run in parallel, and arrangements are provided so that only unit running can be effected.

The turbines are to be of the impulse type, and the sets as a whole conform to normal practice. No effort is made to secure low steam

consumption per K.W. as the increase in price for such turbines could not be merited, since the whole of the exhaust can be absorbed in the calorifiers.

Instrument Board.—For the heating system a three-pen tape chart recorder is provided, giving flow and return temperatures and outside building temperatures.

In this connection it is proposed to operate the system on the "Two hundred rule."

It may be of interest to explain this. The system is designed to operate with a temperature of 180° flow and 155° return, to maintain 60° inside the buildings with 30° outside. That is, a mean temperature of 167·5° will be the average in the radiators.

If the external temperature corresponding to this radiator mean temperature be deducted from two hundred (*i.e.*, 200—30) we get 170°, which is the temperature at which the flow water should leave the calorifier. As the external temperature increases, the flow temperature to be maintained should be reduced to correspond with the difference between the external temperature and two hundred, and *vice versa*. Obviously the constant 200 may be altered to suit any case, depending on the range between outside and inside temperatures for which the system is designed.

The three-pen recorder will maintain a record of the attendant's adjustment to conform to variations of the outside temperature.

A second recording three-pen instrument will record flow and return temperatures of the domestic hot water system and also the boiler steam pressure.

Cold water meters for make up boiler feed water and cold feed to the domestic system are provided and also a feed water meter and coal weighbridge are provided.

By the aid of these instruments and the maintenance of a log book the operating efficiency can be checked at any time.

Other Plant.—Steam-cooking apparatus is provided in the kitchen of the British Troops' Hospital.

Steam laundry and disinfecting plant. This will consist of two rotary washing machines, one soap and soda dissolver, one hydro-extractor and one continuous dryer.

This machinery is driven by a steam engine, as a turbine would consume too much steam for such a small output. The exhaust will pass through a grease eliminator and thence to the continuous dryer. Condensate will be returned to the boiler room and any excess exhaust steam will be blown to atmosphere by a relief valve.

The disinfector is a standard Manlove and Alliot machine, working at 30 lb. sq. in.

Electric irons are not to be used, and ironing will be done by hand, using charcoal irons.

Steam-operated instrument, dressing and bowl sterilizers are

provided in the two operating theatre blocks and also in the Families' Hospital.

The whole of the designs were prepared at Simla by the Engineer-in-Chief's Branch, a special section being formed to deal with the heating and electric schedules for the Quetta Reconstruction.

The scheme was designed in conjunction with the architect, and a close liaison was maintained throughout.

All draughtsmen were Indians, and initially a certain amount of instruction and guidance was necessary in order to acquaint them with the subject, which was for the most part a new departure for these men.

The installation work was carried out by the Air Conditioning Corporation of Bombay and Delhi.

The following figures give some idea of the size of the installation :

Heating.—Total thermal connected loads due to heating, 9,128,054 B.T.U.'s per hour.

Domestic Hot Water.—Total domestic hot water load, 8,619 gallons per hour, heated from 50°F. to 150°F.

Live Steam.—3,200 lb. per hour.

Boiler power installed, three boilers, each 7,000 lb. per hour at 160 lb. sq. in.

Total heating surface in radiators, 47,101 sq. ft.

Sq. ft. of radiators per 1,000 cu. ft. of space heat is 23·4.

Costs.

The costs shown are based on actual tendered prices.

The whole of the stores were imported and the prices included freight, insurance and customs import duty.

Import duty on machinery and radiators averaged 20 per cent. Freight included seaborne charges from England and transport from Karachi to Quetta by rail, which is about 1,000 miles, to an altitude of 5,000 ft. The costs are therefore at least 30 per cent higher than would be the case for a similar installation in England. It is also to be noted that prices of pipes, which form a substantial part of the cost, have advanced 52 per cent during the past twelve months.

Owing to the nature of construction and the use of single-storied buildings, as well as the distance at which the central plant house had to be located from the centre of thermal load, it would not be fair to directly compare the costs of the installation with that of a multi-storied, normally constructed hospital, with a plant room at or near the thermal load centre, or even in a basement as is common practice in hospitals at home.

Due regard must also be given to the duplication of plant which has been provided to ensure continuity of operation.

It appears, however, that all things considered, the costs are, if anything, below the average. In the analysis the costs are given in Sterling. The actual cost erected complete in India, and the assessed costs if erected in England, are given in adjoining columns.

The total cost of the central boiler room plant was only £13,950. Dividing this against the thermal demands of the heating, domestic hot water and steam services, and adding the costs of the various systems, the total costs of each installation, including boilers and plant, was as follows :—

	Heating System.	Domestic Hot Water System.	Steam System.
Boilers and Plant	£6,450	£4,800	£2,700
Pipe System and all fittings (*i.e.*, radiators, taps, etc.)...	£15,860	£4,250	£8,788
TOTAL COST	£22,310	£9,050	£11,488

The volume heated is *2,009,574 cu. ft.*

The area of radiating surface, including radiators and exposed pipes used for heating, is *47,101 sq. ft.*

The area of heating surface per 1,000 cu. ft. heated is *23·4 sq. ft.*

The number of occupants may be taken as not less than 800 persons including duty staff.

	HEATING.		DOMESTIC HOT WATER.	
	Erected at Quetta.	Comparable cost if erected in England (not c.i.f. and duty).	Erected at Quetta.	Comparable cost if erected in England (not c.i.f. and duty).
Cost per 1,000 cu. ft. heated	£11·05	£7·735	£4·5	£3·15
Cost per cu. ft. heated	2·66 pence	1·86 pence	1·08 pence	·756 pence
Cost per sq. ft. radiation	£0·473	£0·331	—	—
Cost per occupant ...	£27·9	£19·52	£11·25	£7·89

It is of interest to note that the costs quoted by Fraber in his text-book *Heating and Air Conditioning in Buildings*, published in 1936 before the increase of pipe and radiator rates to the present levels took place, is given for a single-storied hospital having a volume of 1,048,000 cu. ft. as 2·47 pence per cu. ft., and £45 per occupant.

THE MESSINES RIDGE MINES, 7th June, 1917.

GERMAN ACCOUNTS.

(With Map.)

INTRODUCTION.

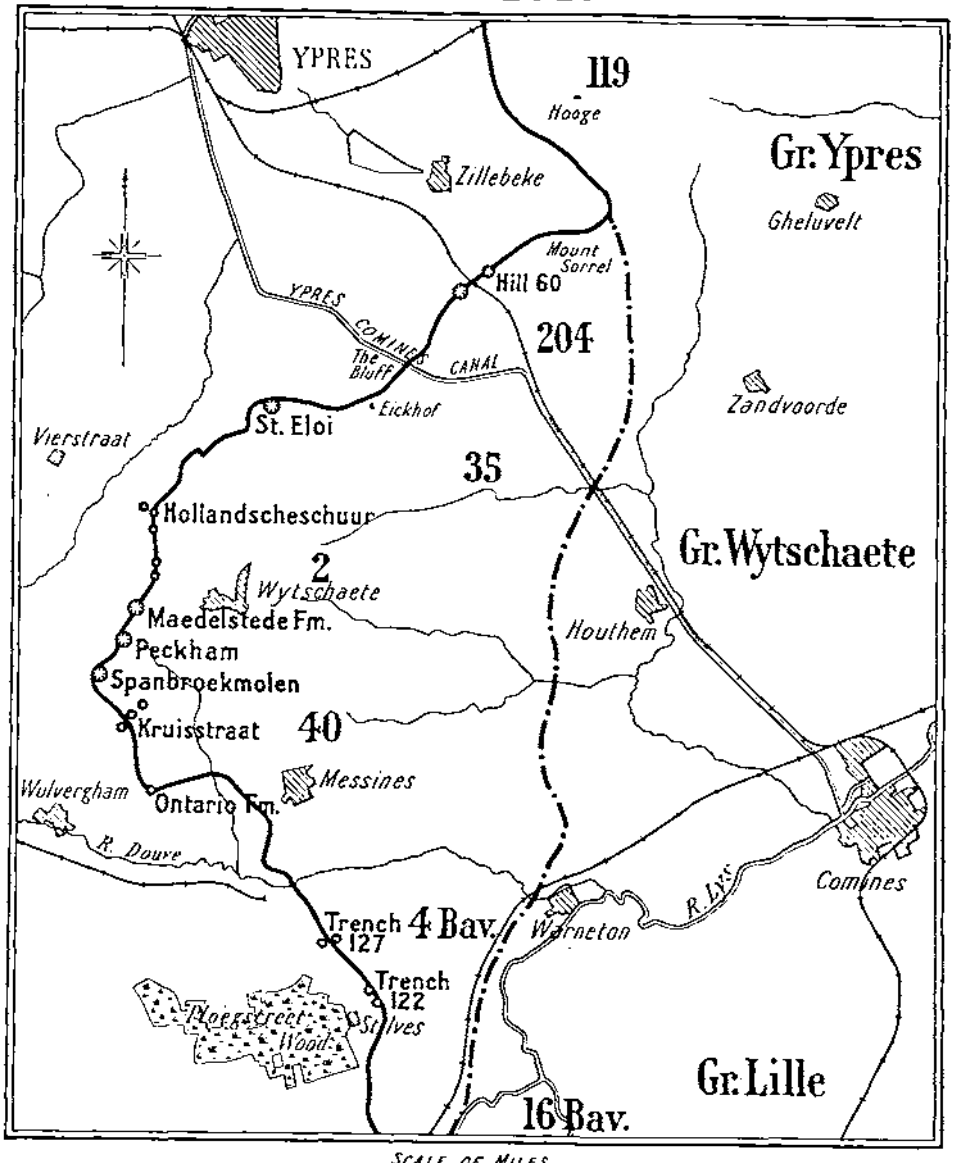
THE British *Official History* at present stops just short of the operations of General Sir Herbert Plumer's Second Army against the Messines–Wytschaete ridge in June, 1917. An excellent account of the tunnelling operations which terminated in the explosion at zero hour of 19 mines, containing a total of high explosive only just short of a million pounds, is, however, available in *Tunnellers*, by Captain W. Grant Grieve (a tunnelling officer) and Bernard Newman.

It may be of interest to many survivors of the war and others—one civilian friend recently confused the Messines mines with the Messina earthquake of a few years earlier—to know what the Germans have to say about this "first black day of the German Army," as one of their regimental histories calls it. The German *Official History*, Volume XII, which was published last year, covers the first half of 1917 and therefore contains the account of the disaster of Messines. The portions of this history which refer to the mining operations are here translated in full, with a few footnotes based on the *Book of Honour of the German Engineers*, 1914–18 (quoted as *E.H.*), which is not always in agreement with the *Official History*. Some extracts from infantry regimental histories have been added as giving colour to the somewhat bald official story of how the German commanders failed to take the advice of their technical officers, suffered defeat in consequence, and then maintained that they had not been warned.

Such portions of the general narrative in the *Official History* as are required to present a continuous story are summarized. For the sake of clearness, "enemy" has throughout been rendered "the British." The English names for localities are given in brackets after the German where necessary.

On the 7th June, 1917, when the 19 British mines were fired under Messines ridge, the German front from Armentières to the sea was held by four corps which in the narrative are, and in operation orders were, called Groups: Lille Group (II. Bavarian Corps) from Armentières to abreast the Douve, a mile south of Messines; Wytschaete Group (XIX. Corps), up to Mount Sorrel; Ypres Group

MESSINES
June 1917



(IX. Reserve Corps) to near Dixmude ; and Northern Group (Naval Corps) to the sea. The first group belonged to the Sixth Army, the other three to the Fourth Army, under General Sixt von Armin ; both these Armies, with the First and Seventh, on their left (south), belonged to Crown Prince Rupprecht of Bavaria's Group of Armies, of which Lieut.-General von Kuhl was Chief of the Staff.

The actual German line, known to our opponents as the " Wytschaete Salient," was an arc, with Wytschaete in the apex, covering the high ground marked by Messines–Wytschaete (the true Messines) Ridge, a spur of the main Ypres Ridge, and thence along the main Ypres Ridge[1] and across the Comines–Ypres canal to Mount Sorrel. From this arc jutted over a dozen small salients, the best known of which were Hollandscheschuur, Maedelstede Farm, Peckham, Spanbroekmolen, Kruisstraat. Thus the whole salient, except a tiny piece south of the Douve, was held by the Wytschaete Corps.

Briefly, the mining operations were first discussed in May, 1915. There had been mining in the Ypres area in the winter of 1914–15 at a level of 15 feet or so below the surface ; but it was then proposed to go down into the blue clay 60 to 90 feet below the surface. A plan was got out in detail by Brig.-General R. N. Harvey, the Inspector of Mines, for six deep mines, and approved later in the year by the General Staff at G.H.Q. They were to be ready by the end of June, 1916. To camouflage the proceedings the shafts were called and signboarded as " Deep Wells."

By the end of June, 1916, four mines were ready and a number of other galleries run ; but the Second Army offensive, which Sir Douglas Haig had planned to carry out should the Somme operations prove unpromising, was postponed. For a year the Tunnellers had to protect the work done ; but at the same time they continued to place new charges, making twenty in all, and continuous mine warfare went on. Nineteen of these mines were fired for the Messines offensive. The twentieth, unfired, still causes anxiety to the Belgian gentleman who is owner of the land above it. Great lakes mark the site of the craters formed by some of the nineteen.

Translation.

The struggle underground in the Ypres and Wytschaete sector was carried on by both sides with great activity. Before the close of 1914 it was in progress at a few places in the Wytschaete Salient at a short distance below the surface, above the water-bearing strata. On the 27th May, 1916, the British had surprised the Germans by firing five large mines [not those of the plan] run near St. Eloi at great depth. Geological investigations carried out immediately

[1] The summit runs from Wytschaete to midway between Hooge and Gheluvelt.

afterwards in the Wytschaete Salient north of the Douve, by Dr. Passarge, disclosed that the British had succeeded in penetrating through the water-bearing strata, generally 15 to 30 feet thick, to the dry Ypres clay, which in every way suited mining. It became necessary on the German side to reorganize mining warfare. From the end of May onwards seven engineer tunnelling companies were successively formed, composed of miners and quarry men, and other soldiers suitable for mine warfare. Each company was about 250 strong. In June, 1916, Lieut.-Colonel Füsslein, an engineer officer who had been on the General Staff, was appointed Commander of the Tunnellers, and put in charge of mine warfare in the Wytschaete Salient,[1] and from 1st September in the whole area of the Fourth Army [from Ploegsteert to the sea]. To assist him, a number of geologists were collected ;[2] this was the more necessary, as he at once found that great ignorance prevailed among his subordinates as to the underground conditions, which had led to a faulty lay-out and to waste of time.[3]

The task of counteracting the British underground attack, which had apparently already made good progress, was rendered more difficult by the defects at once exhibited of the mining apparatus provided. The work, too, in the Wytschaete Salient was frequently interrupted by artillery fire on the entrances to the shafts and galleries. Nearly the whole of the counter-mining, and specially the defence at the deep levels, had to be reorganized. Great difficulty was experienced in dealing with the water-bearing strata, which on the German side were 45 to 60 feet thick, and had all the unpleasant characteristics of a quicksand. It was not until the beginning of September, 1916, after long and fruitless endeavours, that this quicksand was driven through by means of ferro-concrete shafts, and a safe base for the German plan of battle gradually conquered.

On the 25th December, 1916, Lieut.-Colonel Füsslein reported to the Fourth Army that the British deep tunnelling indicated distinctly offensive intentions[4] and that the attack below ground could only be in preparation for an attack above ground, and that he had not sufficient men simultaneously to carry on defence work at the upper level and to drive galleries quickly at the lower level. He asked for four more tunnelling companies ; but only three could be provided. They arrived in the middle of January, 1917.[5]

[1] The German *Official History* omits to mention that he merely succeeded Captain Bindernagel as mining adviser to the Wytschaete Corps. He had under him five tunnelling companies (*E.H.*, p. 541). The other two were employed elsewhere, but came to Messines in January, 1917.

[2] Twelve according to evidence obtained in Lille.

[3] According to *E.H.*, p. 544, Füsslein at once decided to resort to deep mining, sinking the shafts 100 to 300 yards behind the front line.

[4] At this date the British deep mining had been detected at two places only : at St. Eloi and south-west of it at Hollandscheschuur (*E.H.*, p. 546).

[5] This does not agree with *E.H.*, p. 541, which says that in the autumn of 1916 the Supreme Command provided two companies twice, in January, 1917, three more,

The lack of sufficient tunnellers made itself noticeable in various ways; but, at any rate, the work remained under single and skilled leadership, which made full use of those who were available; so the defensive measures were apparently not without success.

* * * * * * *

During March and April the situation below ground, as a result of several successful "blows," appeared to become more favourable. On the 8th March Lieut.-Colonel Füsslein reported that, although surprise British "blows" must be expected at one or two places, a full tunnelling attack on the Wytschaete Salient as the prelude to a great offensive above ground was for the moment no longer possible. On the 15th March he reported:

> "In the Wytschaete Corps sector the situation is unchanged, in that of the 204th Division deep tunnelling has not as yet been detected, and the same remark applies to some parts of the sector of the 40th Division; all other parts of the front are safeguarded."

At the end of April the signs of British mining appeared to decrease in a marked degree. Lieut.-Colonel Füsslein reported this on the 28th April to the Wytschaete Corps, and added that this might mean that the British intended to attack within a short time above ground and had for the moment abandoned all tunnelling where they had encountered German counter-mining and had not reached the German positions.

* * * * * * *

On the 30th April, Crown Prince Rupprecht's Chief of the Staff, Lieut.-General von Kuhl, held a conference of Army and Corps commanders and their chief General Staff officers at the headquarters of the Wytschaete Corps to discuss the situation and decide on action in view of a possible attack. A suggestion was made to evacuate the Wytschaete Salient; but the Army and Corps commanders concerned [Sixt von Armin and von Laffert] were opposed to it, and Kuhl himself thought that the British preparations indicated only a subsidiary attack (*Nebenangriff*) in connection with the situation at Arras, where the battle was still raging. The history then states: "The situation below ground was not apparently mentioned. At any rate, the notes and reports of the conference contain nothing about it." Attention was distracted from Messines by rumours of an intended British attack against Zeebrugge and of a possible landing in Holland; reserves were disposed to deal with these contingencies.

* * * * * * *

and sanctioned the formation of two more companies. These two new companies contained infantrymen who were not miners, as no more of the latter could be spared from the Homeland. This with the original five makes a total of 14, but in March, 1917, 15 companies were working (*E.H.*, p. 546).

Lieut.-Colonel Füsslein's next report is dated 10th May. It ran: "The enemy has apparently abandoned the struggle at the higher level and is everywhere going into greater depth. It seems also to be confirmed that at every place where he has been continuously opposed, he is limiting himself to purely local security, and only attacks where he hopes to pass unnoticed.

"Wytschaete Group. An enemy attack in great depth is still to be expected on both sides of the Ypres–Comines railway, on the canal, on Eickhof Hill, at Hill 73 [Spanbroekmolen] and south of Fransecky Farm [Kruisstraat]. If a great British attack takes place it will be preceded by large 'blows' at some of these places in front of or in our front line." When, on the 2nd May, the Lille Corps [next south of the Wytschaete Corps] was transferred to the Fourth Army, all its battle dug-outs were found to be water-logged. At the suggestion of Lieut.-Colonel Füsslein they were pumped out in order that they might be used as listening-posts. The Fourth Army wrote in its appreciation of the situation for the period 5th–12th May: "Mining activity remains lively." This seems to have applied mainly to the Ypres Corps, in whose sector both sides made several "blows"; for during the period in question the British "blew" no mines in the Wytschaete Corps area, and the Germans only one, south of Wytschaete.

As regards the situation above ground, on the 19th May the Fourth Army report was: "A British attack is not immediately imminent, but the preparations for one always continue."

* * * * * * *

British tunnelling activity on the main front of attack had not been noticed since the end of May; but the British kept the entrances to the German shafts under strong artillery fire, and made it impossible to use them. The German tunnellers were therefore mostly withdrawn, and mining was kept going only near the Ypres–Comines canal and at St. Eloi. The O.C. Tunnellers had reported on the 24th as regards the Wytschaete Corps sector: "On the Ypres–Comines railway and on the canal the situation is unchanged. The mining work observed above ground west of the Small Bastion [The Bluff, on the canal] as well as the definitely confirmed underground work south of Fransecky [Kruisstraat] Farm, now as before, make Eickhof Farm and the ridge south of Fransecky Farm danger spots. Hill 73 [Spanbroekmolen] seems no longer immediately threatened." Here the British gallery was blown in by a German mine. From this and from the earlier reports, Lieut.-Colonel Füsslein was led to believe that the danger of a mine attack against the whole Wytschaete Salient had been averted by the German counter-measures. He was, however, convinced that the necessary safety measures were not complete everywhere, and

that therefore at many places deep " blows " were not only possible but very probable as a prelude to a great British attack. The G.O.C. of the Wytschaete Corps had, however, openly maintained that the danger from such isolated blows was not very great. In his report after the battle he enumerated the places which were still regarded as in danger, and then said :

> " Otherwise the tunnellers were of opinion that no sort of danger by underground attack could any longer exist as regards the position in the Wytschaete Salient, and that we were secured everywhere. If any doubt on the matter had been possible the natural consequence would definitely have been the early evacuation of the whole front position."

General von Laffert hoped to be able to avoid heavy losses by leaving only very small garrisons at the places in the forward lines which were still thought to be threatened.[1] The G.O.C.'s of the Fourth Army and of the Group of Armies also, from all accounts, no longer attributed much importance to mine warfare in the Wytschaete Salient. In any case, it was not mentioned in any of the situation reports of the Fourth Army after the 12th May, and not in those of the Group of Armies after the end of April. Naturally, O.H.L. could hardly come to any different conclusion as regards mining danger, the more so as the reports of its liaison officer, Major Mende, contained nothing about underground warfare after the 2nd May. A footnote adds here that General Wetzell, the strategist and head of General Ludendorff's Operation Section, writing in October, 1938, says that, having been an engineer officer, he had warned his chief of the danger of tunnelling.

Passing to the 5th June, it is stated that although artillery fire and patrol operations greatly increased, and much activity prevailed in improving their position, the British did not appear to be continuing their offensive underground work. Only at one place at the southern part of the Ypres Salient did they make a " blow," without achieving any result. The Germans fired two small mines in defence there.

Towards 3.10 a.m. on the 7th June the British, after a comparatively quiet night, opened the attack by firing 19 great mines in and behind the front German line[2] from the Ypres–Comines railway to St. Yves. The result was overpowering. An eye-witness said " one saw 19 giant roses with crimson leaves or huge mushrooms slowly and majestically rise from the ground. They broke up with a dull roar and immediately columns of bright multi-coloured flames and smoke shot from them carrying masses of dark fragments towards heaven." The trembling of the earth is said to have been

[1] The regimental histories give no indication that he gave any orders on the subject.

[2] Regimental accounts say that all three trenches of the front system were affected.

felt 25 miles away. Every divisional sector of the Wytschaete Corps and the right flank division of the Lille Corps were affected. The worst effects were felt in the 2nd Division, and next to that in the 40th Division, whose infantry had for the most part been relieved by the 3rd Bavarian Division.[1] Simultaneous with the explosion of the mines, drum-fire in the highest degree was opened, and shortly after the first waves of the British infantry stormed forward.

The following account is given in the regimental history of the 104th Infantry Regiment of the 40th Division, which was being relieved by the 23rd Bavarian Infantry Regiment:

> "From 2.30 a.m., after a dark night, the day began slowly to wake, the moon came out and the whole landscape lay in a curious light, a mixture of the moonlight and the young dawn.
>
> "It was so still that one could hear the birds singing. This splendid silence was a fit prologue to a death day for the front fighters.
>
> "Shortly before 3 a.m. the first portions of the 3rd Battalion of the 23rd Regiment appeared in the reserve trenches. The men of the 1st Battalion of the 104th were delighted that all was so quiet. There was not unjustified expectation that they would escape from the witch's kettle of the last few days without serious losses. They hoped in a couple of hours to have a good wash and be clean once more and get a real good sleep. Then at 3.10 a.m. came suddenly 19 explosions which, earthquake-like, disturbed both earth and air. Dark red volcanic eruptions and fountains of fire shot from the ground. The end of the world seemed to have come. Yellow-white flames, probably signals for attack, rose high into the air, and immediately after the whole western sky was bright with the flashes of discharge of the British artillery. A few seconds later the bombardment with hellish noise fell on the front lines from Ypres to Armentières. The sun rose in the east to a wonderful day, but which was to be a black day for the men."
>
> "The great explosions had thrown aside the last remnants of the wire entanglements and put the greater part of the trench garrison out of action, so that the British quickly gained ground."

To quote a British divisional account:

> "There was little resistance from the Germans, who either ran forward to surrender, or, if they could do so, ran away; very few put up a fight." Many of them, including four officers sitting at a table in a concrete dug-out, were found dead without a scratch on them.

The German *Official History* does not mention the casualties. The history of the 104th Regiment gives an estimate for the 7th June

[1] Footnote (in original). The mines were divided as follows:—

4th Bavarian Division [southernmost, south of Messines] ...	4
40th (3rd Bavarian Division) [north of Messines]	5
2nd Division [Wytschaete]	7
35th Division [Canal]	1
204th Division [Mount Sorrel]	2

of 50,000 casualties, of whom 7,200 were taken prisoner, and puts the losses of its own 1st Battalion in killed and missing alone at 9 officers and 259 men. It mentions that the 23rd Bavarian Regiment lost, killed, 1 officer and 34 other ranks; wounded, 3 officers and 242 other ranks; missing, 20 officers and 736 other ranks; and that of the 1st Battalion only 1 officer and 3 men returned.

The histories of only two of the three infantry regiments of the 2nd Division are available: the 4th Grenadiers puts its losses as 46 officers and 1,370 other ranks, "figures which had never been even nearly approached on the previous heaviest battle days." The 44th Infantry Regiment, for the two battalions engaged, gives the casualties as 32 officers and 992 other ranks.

A final episode, although already in print in the *Life of Professor (and Lieut.-Colonel) Sir Edgeworth David*, the geologist of the Tunnelling Companies, will bear repetition. After the Armistice he went to Lille to visit Professor Barrois, the geologist of Lille University, who had remained there during the German occupation. Professor Barrois told him that twelve German geologists had made use of his school and museum. On the morning after the Messines explosions the twelve geologists and, it is believed, Lieut.-Colonel Füsslein, were lined up in the Museum, a German general arrived, cursed them freely for failing to warn him of the mining possibilities on the British side, and ordered those under 40 to join regiments at the front, and those over 40 to go back to their wives.

SOME FURTHER USES OF TUBULAR SCAFFOLDING.

By CAPTAIN H. A. H. RADCLIFFE-SMITH, R.E.

PAMPHLET No. 4 of *M.E.*, Vol. III, Part II, describes Tubular Scaffolding and some of its uses. This equipment has, of course, its limitations, the chief being the weakness of the strongest form of coupler compared with the strength of the tube. However it appears that its uses can cover an even wider field than those described in the pamphlet.

In this article will be described methods of constructing road-bearers, transoms and trusses from tubular scaffolding, using standard equipment only. These methods have not been tried out in practice by the author or anyone he is acquainted with; they are, however, thrown on the market in the hope that someone may put them to the test.

THE DOUBLE TUBE.

If two tubes are joined together, as shown in Fig. 1, allowing a

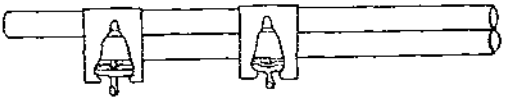


FIG. 1—The Double Tube.

factor of safety of four on the crippling load, the beams shown have moments of resistance :—

2 in., 35/40	3 in., 24/28	3 in., 35/40 (Special)	
10·16	20·16	48·7	in tons.

The standard U-coupler can be used to clip the tubes together and, in order to ensure that there is no movement of one tube relative to the other, the couplers should be spaced at intervals of 2-ft., centre to centre, at the ends of the girder, and at not more than 3-ft. centres in the middle.

Tubes of equal or unequal lengths may be used. If, for example, one 10-ft. and one 8-ft. tube be connected together the resultant beam will be, for use as a roadbearer, as strong as one made of two 10-ft. tubes. Furthermore, it will be lighter and, if used on a tubular transom, will be easier to fix in position.

The Treble Tube.

If three tubes are connected together as shown in Fig. 2 the

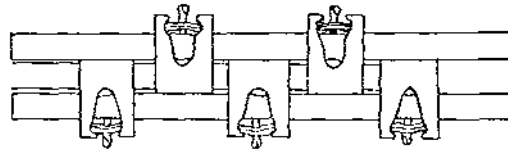


Fig. 2—The Treble Tube.

beams shown will have moments of resistance, allowing a factor of safety of four on the crippling load, of :—

2 in., 35/40	3 in., 24/28	3 in., 35/40 (Special)
27·2	44·7	107 in tons.

As in the case of the double tube, sufficient couplers must be used to ensure rigidity ; this can be effected by spacing the couplers on the centre tube at an interval of 1-ft. centres, in which case they will be at 2-ft. centres on each outer tube.

Owing to the coupler on the upper tube facing upwards, this form of construction is unsuitable for use for roadbearers. The treble tube may, however, be used with advantage for transoms, in which case it should be constructed as shown in Fig. 2, having two long tubes top and bottom, and one shorter tube in the centre. This enables two couplers to be used direct between the transom and each upright with obvious advantages.

Trusses.

Various types of trusses are shown in Figs. 3, 4, 5 and 6, designed to take medium loads as calculated in Appendices I, II and III.

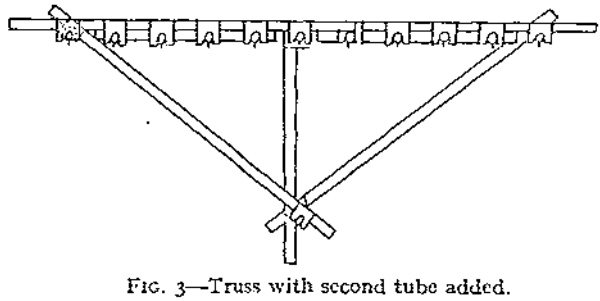


Fig. 3—Truss with second tube added.

The longitudinal, diagonal and vertical members are all connected to transverse tubes running at right angles to the truss.

U-couplers are used, as these are flexible and give the effect of pin jointing. One of these clips will take 1 ton for 2-in. tubes and 3½ tons for 3-in. tubes, and they may be used singly or in pairs or threes

according to the load to be taken by the tube. In all cases the additional couplers must be placed on the correct side of the joint, according to whether the tube is in compression or tension.

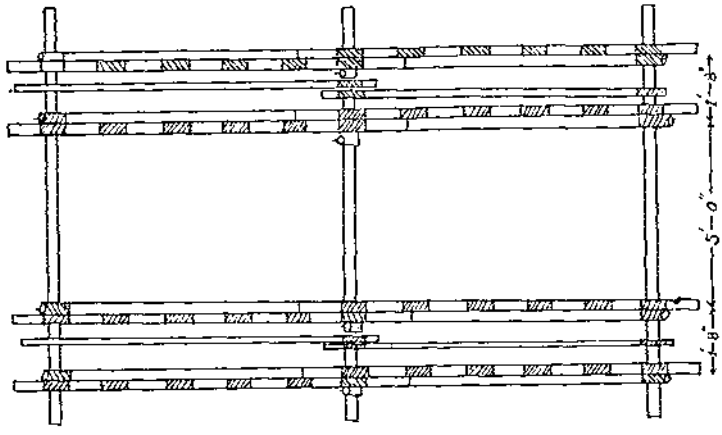


FIG. 4—16-ft. Truss for Medium Loads direct Loading.

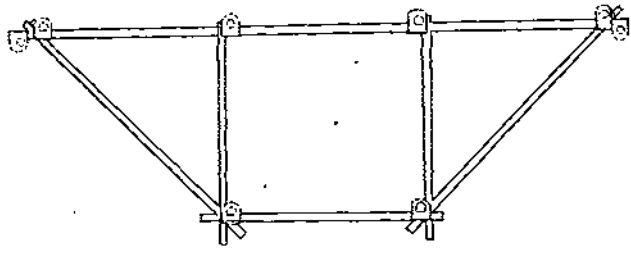


FIG. 5—30-ft. Truss for Medium Loads.

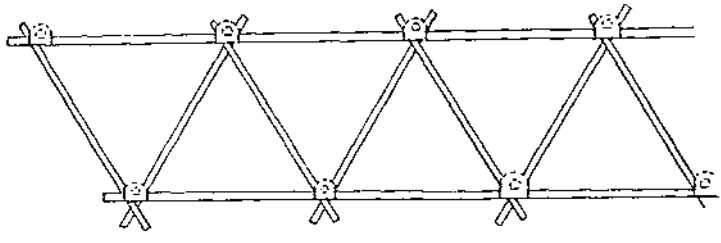


FIG. 6—80-ft. Truss for Medium Loads.

These trusses may be directly loaded if a second tube is added to the top member, as shown in Fig. 3. In such cases the double tube will act as a roadbearer for which its strength must be calculated. In Tables I, II and III are given figures from which suitable trusses can be selected for various spans and loads, and examples will be found in Appendices I, II and III.

TABLE I.

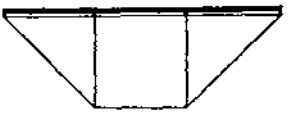
Strains in members of King Post Truss caused by load W evenly distributed on bearers, which are supported at the panel points of the truss.

The depth is measured from the centre of the top member to the centre of the diagonal where joined to the bottom transverse member.

Span	Depth	Vertical Member	Horizont. Member	Diagonal Member	Span	Depth	Vertical Member	Horizont. Member	Diagonal Member
12	3	·5W	·49W	·55W	18	4	·5W	·58W	·62W
12	4	·5W	·37W	·45W	18	5	·5W	·45W	·52W
12	5	·5W	·30W	·39W	18	6	·5W	·37W	·45W
14	4	·5W	·48W	·54W	20	5	·5W	·5W	·57W
14	5	·5W	·35W	·44W	20	6	·5W	·42W	·49W
14	6	·5W	·29W	·38W	20	7	·5W	·35W	·44W
16	4	·5W	·49W	·55W					
16	5	·5W	·40W	·48W					
16	6	·5W	·33W	·42W					

TABLE II.

Strains in members of Queen Post Truss caused by load W evenly distributed on bearers, which are supported at the panel points of the truss.

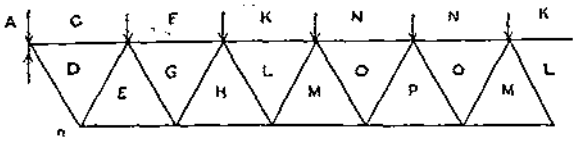


The depth is measured from the centre of the top to the centre of the bottom boom.

Span	Depth	Vertical Member	Horizont. Member	Diagonal Member	Span	Depth	Vertical Member	Horizont. Member	Diagonal Member
18	4	·33W	·49W	·59W	27	6	·33W	·50W	·60W
18	5	·33W	·40W	·52W	27	7	·33W	·43W	·56W
18	6	·33W	·33W	·47W	27	8	·33W	·37W	·50W
21	5	·33W	·47W	·57W	27	9	·33W	·33W	·47W
21	6	·33W	·39W	·51W	30	6	·33W	·56W	·65W
21	7	·33W	·33W	·47W	30	7	·33W	·47W	·58W
24	6	·33W	·44W	·55W	30	8	·33W	·41W	·53W
24	7	·33W	·38W	·5W	30	9	·33W	·38W	·50W
24	8	·33W	·33W	·47W	30	10	·33W	·33W	·47W

TABLE III.

Strains in members of a Warren Truss caused by load W evenly distributed on bearers, which are supported at the panel points of the truss.



Note: — denotes members in tension.
+ denotes members in compression.

Member.	40-ft. Span.	50-ft. Span.	60-ft. Span.	70-ft. Span.	80-ft. Span.
+cd	·22	·23	·24	·25	·26
+fg	·51	·58	·63	·75	·69
+kl	–	·68	·82	·89	·99
+no	–	–	–	–	1·18
−db = +dc	·44	·46	·48	·49	·51
−ge = +gh	·15	·22	·28	·32	·36
−lh = +lm	–	0	·10	·16	·23
−om = +op	–	–	–	–	·075
−bc	·44	·46	·48	·49	·51
−bh	·59	·68	·77	·81	·88
−bm	–	–	·87	·97	1·10
−bp	–	–	–	–	1·18

APPENDIX I.

Data: Span, 16 ft.
Loads, medium.
Tubes, 3 in., either 24/27 7-gauge or 35/40 special.

1.—ROADBEARERS.

Allow six r.b.'s, then each will take 25 per cent of the live load and 1/6th of the dead load.

Decking, 3", Wt. $= \frac{3}{12} \times 12 \times 16 \times 35 = 1{,}680$ lb.

Wt. per 8-ft. span = 840 lb.

r.b.'s, Wt. $= 6(8{\cdot}97 \times 2 \times 8 + 15{\cdot}8 \times 4)$
$= 6(144 + 632)$
$= 6 \times 207{\cdot}2$
$= 1{,}243{\cdot}2$ lb.

Max. live load $= 5{\cdot}7 \times 1{\cdot}5$ tons

Max. B.M. $= \frac{840 + 1{,}243}{6 \times 8} \times 8$ ft. lbs. $+ \frac{5{\cdot}7 \times 1{\cdot}5 \times 8}{4 \times 4}$ ft. tons

$= \frac{2{,}083 \times 12}{6 \times 2{,}240} + \frac{5{\cdot}7 \times 3 \times 12}{4}$ in tons

$= 1{\cdot}86 + 51{\cdot}3$

$= 53{\cdot}2$ in tons.

Now the M_R of one double tube = 48·7 in tons. Hence if these are used the factor of safety will be slightly less than 4, in the case of special 35/40 ton tubes; other tubes are not suitable.

2.—Girders.

Allow four girders, each to take 1/4th of the dead and ·40 of the live load.

Wt. of girder $= 4(8{\cdot}97 \times 50 + 15{\cdot}8 \times 10)$
$= 4 \times 656.$
E.U.D.D.L. from Table I, *M.E.*, Vol. III = 17·2 tons.

$$\text{Max. load per girder} = \frac{2{,}083 \times 2}{4 \times 2{,}240} + \frac{656}{2{,}240} + 17{\cdot}2 \times {\cdot}4 \text{ tons}$$
$$= {\cdot}63 + 6{\cdot}88$$
$$= 7{\cdot}51 \text{ tons.}$$

From Table I, for a 16-ft. truss, depth 6 ft.
Load in vertical = 3·76 tons.
horizontal = 2·48 tons.
diagonal = 3·15 tons.

From the Table on page 12 of Pamphlet No. 4, *M.E.*, Vol. III, Part II, it appears that either 24/28 or 35/40 tubes will do and in either case only one coupler per joint will be required for the horizontal and diagonal members, and two for the vertical member.

APPENDIX II.

Data: Span, 30 ft.
Loads, medium.
Tubes, 3″, either 24/27 7-gauge or 35/40 special.

1.—Roadbearers.

Allow six r.b.'s, then each will take 25 per cent of the live load and 1/6th of the dead load.

Decking, 3″, Wt. per bay $= \frac{3}{12} \times 12 \times 10 \times 35 = 950$ lb.
r.b.'s, Wt. = 6 × 16 × 10 = 960 lb. for 7″ × 4″ r.s.j.'s.
Dead load per bay = 1,910 lb.
Max. live load per bay = 5·7 × 1·5 tons.

$$\text{E.U.D.D. load per r.b.} = \frac{1{,}910}{6 \times 2{,}240} + \frac{5{\cdot}7 \times 1{\cdot}5}{4}$$
$$= 0{\cdot}14 + 2{\cdot}15 = 2{\cdot}3 \text{ tons.}$$

Hence, from Table 16, 7″ × 4″ r.s.j.'s will do.

2.—Girders.

Allow six girders, each to take 1/6th of the dead load and ·25 of the live load.

Wt. of girders $= 6(8{\cdot}97 \times 110 + 15{\cdot}8 \times 16) = (990 + 253)6$
$= 1{,}243 \times 6$ lb.

E.U.D.D.L. from Table I $= 21{\cdot}4$ tons.

Max. load per girders $= \frac{1{,}910 \times 3}{6 \times 2{,}240} + \frac{1{,}243}{2{,}240} + \frac{21{\cdot}4}{4}$
$= {\cdot}425 + {\cdot}555 + 5{\cdot}35 = 6{\cdot}33$ tons.

From Table II, for a 30-ft. truss, depth 10 ft.

Load in vertical member $= 2{\cdot}1$ tons.
horizontal ,, $= 2{\cdot}1$ tons.
diagonal ,, $= 3{\cdot}0$ tons.

From the Table on page 12 of Pamphlet No. 4, of *M.E.*, Vol. III, Part II, either 24/28 or 35/40 tubes will do and one clip will be required at each joint.

APPENDIX III.

Data: Span, 80 ft.
Loads, medium.
Tubes, 3", 35/40 special tubes available.

1.—Dead Load.

Decking, 3", Wt. $= \frac{3}{12} \times 12 \times 35 \times 80 = 8{,}400$ lb.

r.b.'s, Wt. $= 6 \times 80 \times 16 \times 1{\cdot}2 = 9{,}220$ lb. (Say $6 \times 7" \times 4"$.)

Girders: allow six girders with double top and bottom booms.

Wt. $= 6(2 \times 80 + 2 \times 70 + 10 \times 16) + 12 \times 17 \times 8{\cdot}97$
$+ 15{\cdot}8 \times 2 \times 6 \times 17 \times 4$
$= 8{\cdot}97\,(6 \times 460 + 204) + 12{,}900 = 26{,}600 + 12{,}900$
$= 39{,}500.$

Total dead load $= 57{,}120$ lb. $= 25.5$ tons.

2.—Live Loads.

From Table I, *M.E.*, Vol. III.
E.U.D.D.L. $= 37{\cdot}2$ tons.

3.—Load Per Girders.

Load per girder $= \frac{1}{6}$ dead load $+ \frac{1}{4}$ live load $= 4{\cdot}25 + 9{\cdot}3 = 13{\cdot}55$ tons.

4.—Load in Members.

From Table III.

cd $= 3{\cdot}52$	Top boom.	eb $= -6{\cdot}9$	Bottom boom.
fg $= 9{\cdot}2$		hb $= -12{\cdot}0$	
kl $= 13{\cdot}4$		mb $= -14{\cdot}9$	
on $= 16{\cdot}0$		pb $= 16{\cdot}0$	

$-$db $= +$de $= 6{\cdot}9$	Diagonals.
$-$eg $= +$gh $= 4{\cdot}9$	
$-$hi $= +$lm $= 3{\cdot}1$	
$-$mn $= +$np $= 1{\cdot}0$	

$-$ denotes member in tension.
$+$ denotes member in compression.

5.—Strength of Tubes.

The Table on page 12 of Pamphlet No. 4, *M.E.*, Vol. III, Part II, gives the crippling load for a 3-in. tube as 37·2 tons. Now two couplers will take 7 tons which will allow a factor of safety of over five on the tubes.

6.—Number of Tubes.

With one coupler the tube will take 3·5 tons. With two couplers the tube will take 7 tons. Hence all diagonals can be single tubes, double couplers, however, will be required in the four diagonals nearest to each end and for increased rigidity it will be advisable to have two tubes in each case with only one coupler on each end.

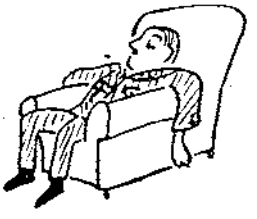
The top boom requires only a single tube with a single coupler in the first section. For increased rigidity it will be advisable to have two tubes, each with single couplers. Two tubes with double couplers will be required in the second and third sections, while treble couplers will be required in the fourth section.

The bottom boom should have two tubes throughout, single couplers in the first section, double in the second and treble in the third and fourth.

TRAINING AND THINKING.

By "SENTRY."

A SPEAKER, admittedly of strong and attractive personality, was giving a talk of general advice as to how to tackle Army life, to an audience consisting mostly of the equivalent of "privates." He successfully "got across" and made a lasting impression with his peroration, which concluded on the lines that, "You are now part of a team which is doing its best to fit itself for war. It's up to each one of you to pull his full weight. Anyone who does less at all times than his absolute best is nothing better than a damned traitor." The speaker admitted that he had allowed himself to be carried away by a very responsive audience. Whether the address had anything to do with it, or whether the general lines adopted for training were responsible, one thing is certain; the unit concerned worked as one man towards the common objective.*



TRAINING AND THINKING

There is little need to emphasize the immense responsibility resting on all those whose duty is in any way connected with training. There can be no sharper inducement to prolonged effort than the knowledge that lives will for certain depend upon the results achieved. There can be no greater opportunity given to an officer than that of training men he will later lead on active service. In some cases, the time available is all too short, and there must be present in the minds of many the thought, "Shall I be able later on to satisfy my conscience that the best possible use was made of the period of training?"

For those who feel this way, there are many publications available. But much reading may lead to a period of mental indigestion, if it is not controlled; and it may lead to those disadvantages which arise from second-hand thoughts being passed down. There is no substitute whatever for individual and original thought on the part of all those who are training or being trained.

In developing this idea, it will be found that some stress is laid

* When I was on the Square in 1884, we were commanded by a little man named Bruce Brine. Before each exercise he would shout, "Now this is a thing we Sappers used to do right well!" And we *did* pull ourselves together!
Editor, R.E.J.

on the need for leaving a good deal to subordinates (right down to "Privates"). A possible deduction might be that other fundamentally important principles of army life must be infringed. No deduction could be further from the truth. The foundations of good training are the same as those required for all phases of army life. The chain of command, and of responsibility, must be closely adhered to; the discipline must be first class; organization and administration must be the best possible.

The first essential for effective training is co-operation by all concerned. This co-operation must be based on a way of thinking, or a frame of mind. In commanders of all grades this point is most important; to take the example of a platoon commander, he must not consider himself primarily as a rugger international, or as a member of the officer's mess. He is primarily an integral part of his platoon. The point is not an academic one. All the best methods of training aim at inducing that frame of mind in which each individual recognizes himself as a member of a corporate body which needs his individual co-operation for success. To obtain this frame of mind among the soldiers, two things are necessary. They must be well-informed; in other words, they must know to a considerable extent what is at the back of their officers' minds during each phase of training. In addition, they must feel that they are trusted; the little finger of conscience must if possible be more troublesome to them than the loins of compulsion.

This argument leads to the question of confidence. The ideal state for a commander to find himself in, is to know that when he gives out an order or an idea, each subordinate right down the chain of command will follow up that idea, adding what is necessary for his particular circumstances. All that remains for the commander is to co-ordinate effort as the idea develops, and to back his subordinates through thick and thin. But there is never perfection, and a commander is running a risk of being "let down" if he places too much confidence in subordinates. But if he knows his job his confidence is not blind, and his main job will be that of judging how far to let his confidence run, and at what stage to interpose. In general, during training it is probably worth taking many risks; an occasional scandal is far more than counter-balanced by the build-up of tone and initiative which is impossible if there is much interference after orders have been given, and ideas disseminated.

The first question which arises in considering the methods to be adopted is that of how to obtain co-operative thought in a unit or sub-unit. An example of how the problem can be tackled is provided by an address made by a C.O., which was reprinted recently in *The Sapper*. It was an extract from *The Fighting Soldier*, a book which is well worth reading right through. Apart from being an example of the psychological approach to the "confidence" question, the

address suggests many points which need attention in any unit. The results of this address are not known, and it is necessary to turn to a much less distinguished talk to find an example where cause and effect can be definitely cited. In an address to recently-joined recruits, in peace, the following points were made (among others). For brevity, the extracts are given in note form.

" Object of talk : to give information to help you.

" When training starts, you are among strange faces, and everyone seems to hate you ; you compete under great difficulties in a hard world ; results, possibly, depression and misgivings ; don't get worried, we have all gone through it.

" Object of training : apprenticeship, low pay, hard work, lots of kicks. Remember, good training must extend a man beyond what he would do normally, and at times should extend him right up to what he can do. Is it worth while ?

" Results of training : personal value increased, physical strength and endurance, knowledge, smartness, health. Done to make a soldier of you, but it's all-important from your own point of view.

" Army career : opportunities in different lines, trade, command, works, P.T. (and other peace-time lines).

(Some points relevent to peace-time soldiering here.)

" Influence : don't get led astray by men wanting company ; army treats you as a man, make up your own mind about things.

" Aids : no unnecessary hardship, we try not to mess you about ; (as corrective—but a certain standard is going to be reached) ; if in trouble, officers, padre, etc., there to help, so think about getting things off your chest, before doing anything really stupid, and bringing everyone in against you.

" Try and realize job N.C.O's have got, and co-operate with them to put up a good show ; Army life all team work."

The results of this talk—one of several experiments—was most impressive in positive terms, such as percentages gained in " passing off," in educational certificates, in the absence of punishments, and all achieved with the minimum of " pressure." For instance, the usual bugbear of conservancy was utterly defeated in a couple of weeks ; the man took less than the average time to reach a standard far above the average, and this—after two weeks—without supervision of any sort ; one N.C.O. was detailed to ensure that the men could get anything they needed at once (for instance, replacement of a lost or worn-out scrubber). Two by-products of this case are worth noting ; N.C.O's became available for extra training, as they were not wanted to supervise on certain jobs ; and the responsible officer on saying good-bye to the party was able to tell them with absolute truth that all his contacts with that party had given him nothing but pleasure. Admittedly he was lucky, as the inevitable bad hats either did not have time to become nuisances, or

were not strong enough to stand up to the general tone of the rest.

If after due thought, a commander of any grade decides to accept the principle of " confidence," his first step is thus to get his ideas across to all his subordinates. He may do this through the medium of some form of address, or he may find other means, better suited to his particular circumstances. If the ideas so transmitted are really sound, and really accepted by both the commander and his subordinates, a perfectly logical line of conduct emerges for disciplinary and administrative matters. This is not relevant here, but pursuit of this line will require on the part of every commander a lot of hard thinking (including " thinking ahead "), as well as hard work. Otherwise he cannot be sure that his more detailed training methods will develop logically and according to plan.

CONFIDENCE

All officers will have had the opportunity of digesting recent official publications on this subject, and can judge the extent to which the line of thought so far pursued lies behind the methods officially suggested ; in other words, is the principle of " confidence " a sound one, or are " brute force " and " cramming " better ? The writer would not have taken upon himself to go so far if he had any doubts on this point.

As indicated above, considerable thought is required in evolving methods of training. Illustrations of this point in official publications have naturally been drawn from large and numerous units ; it might be of more value here to draw examples, which though of wide application, are pegged to a common R.E. unit, such as a Field Company. In discussing the thought necessary for good training, no attempt is made to provide any sort of programme for tackling any subject, nor is any attempt made to cover all the subjects in which a unit must be versed.

The matter of drill is frequently a thorn in the side of the R.E. unit commander. Is it correct to consider that drill has served its purpose in the Royal Engineers if it provides for a reasonably orderly progression of numbers of men from one point to another, and of getting parties on and off essential guard duties ? Most people would say " NO," but with a strong mental reservation that " We can't afford much time for drill for disciplinary or ceremonial purposes." All units have this problem, and with a little thought, some sort of satisfactory solution can be found, even if to some extent it has to be a compromise. Drill for discipline, ceremonial or tradition is

utterly valueless, and indeed positively harmful, unless it is really good drill. Good drill is most easily obtained by the real co-operation of the men ; but few men are very enthusiastic about being drilled, and are still less so if their N.C.O's are inexpert, and land them in extra instruction.

There lies the real problem, and the solution is not an impossible one if thought is given to methods. Firstly, the men must be convinced that an adequate standard (according to the commander's ideas) is quite definitely going to be maintained. If possible, they should be convinced of the reasons underlying this state of affairs. Secondly, they should know that this standard must in the commander's view be maintained with the minimum expenditure of time and bother for all concerned. The rest of the story is one of detail. By hook or by crook, the N.C.O's must be kept up to a standard which prevents them letting down their men ; this is not nearly as difficult as some people think. There must be inducement for all to work hard in the available time. This can be achieved by dismissing parties as they reach the required standard in the subject for which a drill period has been set aside ; the best party goes after half an hour, the next a bit later, then the bulk after precisely 45 minutes.

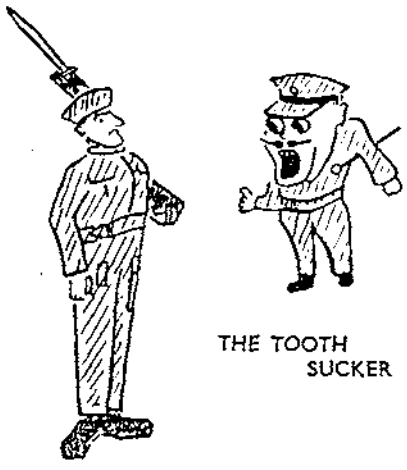
If the commander feels inclined to carry the " confidence " idea a little further, he can tell his subordinates that there will be three drill periods available before next Thursday, and that on that day he will be expecting on his parade that such and such a subject (or subjects) will be right up to standard. He will make it plain that it means nothing to him if his subordinates spend their three periods drinking beer or drilling, provided his idea of an adequate standard is forthcoming on Thursday.

BEER OR DRILL

There are plenty of methods, if thought is given. What is so painful is to see an N.C.O. standing and damning collectively a group of stolid tooth suckers, instead of seeing a lively and responsive squad, with opprobrious comments limited to the one (or at most two) laggards.

Instruction in Field Works is a subject which provides a wide scope for drawing in co-operation from every rank. A period on a simple subject like knotting and lashing can be livened up by a little thought. For instance, take some particular knot, name it, give one demonstration, and call on a test. With luck, about half will succeed, about half will fail. Make up the squad into pairs of men, each of one success and one failure, and tell each pair to get

busy. This will lead to great excitement, as about half the original successes will have been achieved by a fluke. The resulting scene of activity can easily be contrasted with the somewhat common sight of a single dispirited N.C.O. showing a party of men, many of whom cannot see properly, the seventeenth demonstration of the knot. Incidentally, this form of instruction in knotting and lashing leads to quick and permanent results.



THE TOOTH SUCKER

The same sort of idea can be applied to many phases of the individual training side of Field Works. Throughout training, interest can be kept alive by emphasizing the personal responsibility of the Sapper, since the ignorance or carelessness of a single Sapper can frequently wreck quite a big operation. One bad bit of work can cause a section to drop a bridge in launching; one badly-jointed fuze may cause a failure in a demolition; one flaw in a water-supply system may mean that the whole job has to be taken to pieces and re-done; and so forth.

A further inducement which reaches everybody is provided by keeping up a reasonable competitive spirit. This should be designed to bring in not only the individual but also the corporate idea. If properly handled, it should not become a nuisance, but should strengthen the feeling of responsibility among subordinate commanders. In addition, it makes it easier for any commander to keep the standard of his sub-units approximately uniform, or to spot at once any weaknesses.

In some units, there are opportunities for individual trades training. In this case, it is difficult to work up the corporate idea, and interest, and therefore co-operation by all concerned, must be obtained by making the work as objective as possible. The most obvious solution is to provide each trade with a series of tasks or tests, so that each man can see a series of limited objectives stretching out in front of him. He should know the whole programme, so that when on a particularly dull test, he knows that the sooner he is through it, the sooner he will get on to something more interesting. Variety can be gained by combining "graduates" from different trades, as they reach a certain standard, into little parties for some test which needs the services of several different tradesmen.

Turning to somewhat more advanced Field Works training, for which sub-units of various sizes are needed, there are at least two ways of laying out a programme. It may be blocked out in terms of periods for " Bridging," " Water Supply," and so on. Alternatively, it can be blocked out as " Sub-section," " Section " and " Company " training. The former is often inevitable, but it is not necessarily the best.

Consider the possibility of a period of Sub-section training. Some dozen tasks, suitable for about a day's work each for a sub-section, are thought out. For examples, take a small water point to be laid out, put up, and made ready for use ; the erection of a small derrick, and completion of some job with it ; launching a small girder (possibly with the aid of a lorry ; involving a non-standard method) ; laying out and digging the " formation " for a banked curve on a gradient ; lay-out of a trench system according to some plan ; and so on. Publish the whole list, and allocate sub-sections to jobs for the first two or three days—each day a different job, of course. Thereafter allocate jobs just before work has to start. Insist on stores all being drawn in one operation (no returning for things forgotten).

Such a system needs a lot of spadework by officers, to ensure that N.C.O's are not hindered by administrative or other bungles which lose them time. Also, if any risks are involved, parties must be carefully watched at critical times. But if properly laid on, such a programme is full of interest for everybody. An enormous amount of " shop " is talked out of working hours. Notebooks take on a real practical significance. The work is " taskwork " and the men jump to it without pressure. Every sub-unit commander has his own show, and quickly gains confidence (or busts).

The application of the same idea for Section and Company training is obvious. Throughout the whole programme, there are opportunities for trying out all ranks in jobs normally done by more senior ranks.

Passing now from the field of endeavour covered by the normal training programme included in the normal hours of work, there is still a wide field to be found elsewhere, especially if everybody in a unit is really keen. There has been some matter in the press on the subject of looking after the man's mind, and filling in his spare time. To many this makes sorry reading. For instance, the peace-time education standards included many subjects which are indispensable to the efficient N.C.O. and soldier. Time is found for some of these subjects, to a limited extent, in working hours' programmes. But if a unit can be convinced of the value of such subjects, and if it is a keen unit, there will be a surprising attendance at voluntary evening classes. If such a scheme is adopted, again much thought is needed. Since they are voluntary, the classes must have a somewhat different

character to working hour classes. In addition, they must be thoroughly alive ; if they are dull they will not survive ; and they must have variety. " Outside lecturers " can always be obtained for such functions, since little preparation is needed for such talks. The subject matter which can be taken on is almost limitless.

It may be that for some units, this latter form of work will become increasingly important. Some units may not be needed for service for some time, and it is essential that such units do not deteriorate through misuse of spare time, during the difficult period of waiting. The problem will not be one only of filling in spare time, but of filling it in really wisely. No commander need feel apprehensive about having too long a time in which to train his unit. There are few unit commanders who having commanded their units for a period of years in peace-time could honestly say that they could not improve matters if they were given another year. The danger lies in staleness and boredom, particularly when it permeates downwards from a high source ; and there should be little reason for this, when any unit at any time knows that it may be called on to go on active service, should circumstances suddenly alter. But action against a possible feeling of disappointment, even of annoyance, at prolonged waiting is very essential, and much of such action can best be taken out of working hours.

Apart from the thought required if the full co-operation of all concerned is to be secured throughout training, there are innumerable other points which need thinking out. For instance, a programme should always be balanced. Taking the simple example of barrack square training, it is obviously wrong to call upon the man one day to carry out a curriculum exclusively consisting of drill, P.T., and other violent forms of training, whereas on the next he is exclusively employed on lectures and other comparatively sedentary occupations. The same idea applies to all forms of training, particularly to individual training. The object here is not primarily to get co-operation, though without a reasonable programme the men can hardly be expected to be enthusiastic at all times ; but unless the men are kept fresh, they simply cannot be trained.

This leads to another important point, that of leave. There is necessarily a limit to the amount of leave of long periods ; these are partly governed by regulation, and partly by economics. But if one looks back on school days, one can remember the enormous pleasure derived from the odd extra and unexpected half-holiday. This point is well worth remembering if the unit has been getting along well. The knowledge that there are the extra " baksheeh " half-holidays to be had, if the O.C. is kept in a good mood, will undoubtedly give a fillip to the work of the unit, which will more than compensate for the few working hours lost.

In this connection, however, it is as well to remember the extreme tightness of funds from which the average soldier suffers at most times after Sunday evening. If a real freshener is proposed for a Thursday, some form of "laid on" party is advisable. If the cost is partly met from unit funds, and partly met from an advance from men wishing to join in, it is generally possible (especially in these days of mechanization) to provide some form of welcome outing, and at an extremely low cost to either the unit or the men.

It would be wearisome to multiply instances of the detailed thought required during training. The idea that continuous thought is required of all under training is not a new one; but it is not one of great antiquity, if the evidence of anything but comparatively recent military literature is to be believed. In fact, if ancient military literature is to be believed, the soldier was hardly considered as human, and his mind was not apparently worth bothering about. In *Ward's Animadversions of Warre* (1639) there are one or two glimmers; for instance, the C.O. is enjoined to have "A well-governed and religious preacher to his regiment, so that by his life and doctrine the souldiers may be drawn to goodness." The next instruction unfortunately made this appointment a difficult one, since it ran—"No sutler shall draw any beere in the time of divine service and sermon." He goes on later to state that the serjeant-major shall "Not only be a good scholler and witty, but he must be quick in apprehension, and furnisht with an able memory." Speaking of the Captain, he states: "He must be familiar and eloquent in persuading and diswading his souldiers, and to stir up their valors to undergoe pain and perill." But these advices are lost among pages and pages of instructions, many of them on matters of little application to war, or training.

Cromwell's views are well known, and he can almost be heard saying, in 1643, "My troops increase; I have a lovely Company; you would respect them did you know them." On the other hand, Oman says of Wellington, "Anything that seemed to Wellington to partake of thinking for oneself was an unpardonable sin in a subordinate." Later, Oman says, "This determination to allow no liberty of action to his lieutenants . . . effectually prevented Wellington from forming a school of generals capable of carrying out large independent operations."

The truth is that until comparatively recent times, many leaders were presented with such extremely difficult material to work on, and the principles on which discipline was enforced were so faulty that it was almost impossible to carry out effective training as we understand it to-day. It is to the eternal credit of both leaders and rank and file that in spite of this the army in the past centuries

achieved the record it holds, and built up the tradition it now possesses.

No such difficulties exist now. The raw material entering the Army is the finest in the world. Taken collectively, owing to wise method of application of compulsory service, it is possibly the best raw material that any army has ever had. The military code which forms the background to discipline is based on the soundest principles, and has stood the test of time. All that remains is to ensure that in welding together this Army nothing is omitted towards obtaining the best possible results from these advantages.

THE BRITISH CANADIAN ARCTIC EXPEDITION.

By LIEUTENANT P. M. BENNETT, R.E.

(Reprinted from *The Geographical Journal*, February, 1940, by kind permission of the Royal Geographical Society.)

THIS is an account of the work of the British Expedition to the Canadian Arctic, which with the support of the Royal Geographical Society left England early in 1936, together with a description of the surveys carried out up to the autumn of 1937. An account of the doings of two members of the party for a portion of the period appeared in *The Times* in May, 1938. When the members still in the field have returned, it will be possible to complete the record of the expedition's work as a whole.

T. H. Manning, the leader, had spent the years 1933-35 on Southampton Island, but had difficulties with his wireless receiving set and had been unable to pick up the time signals for his astronomical fixes. He succeeded in running compass traverses round most of the coast-line and along the main watersheds of the interior, but lacked the necessary fixes to tie his traverses. The north-east portion of the island consists of ranges of gneiss hills falling steeply into Foxe basin, and along this shore the sea remains open throughout the year right up to the base of the cliffs, thus making it impossible for a dog-sledge to travel along the shore.

The first objective of the expedition from the survey viewpoint was to complete Manning's map of Southampton Island by obtaining the necessary astronomical fixes and by making a summer sea trip along the eastern coast. It was intended to reach Southampton Island early in the summer of 1936, to spend the summer in the south of the island, sail up the west coast, and form a winter base in Repulse Bay on the Canadian mainland, and to spend the winter surveying the coast-line and interior in that region. Ice conditions permitting, an early start would be made in the summer of 1937, when the intention was to sail down the east coast of Southampton Island, cross Foxe Channel, visiting Dorset, Mill and Nottingham Islands, and connect with the R.M.S. *Nascopie* at Cape Dorset in S.W. Baffin Island. From Cape Dorset the boat would be taken as far as possible up the west coast of Baffin Island, and a winter base established from which the coast and interior could be surveyed.

The arctic summer lends itself to intense scientific activity during

the short period when the land is unfrozen, and the scientist should spend a considerable time in one locality, in order to make his collection as comprehensive as possible, whereas the surveyor is constantly anxious to advance to fresh ground. These two objectives will clash, but they will frequently be settled by an uncontrollable factor: the condition of the sea-ice, which will decide the possibility of movement. In the winter months, once the sea-ice has formed, travelling conditions are more calculable, and the surveyor has a better chance of achieving his objective, though his plans will often be defeated by soft snow and drift, and consequent slow travel, shortage of dog food, and lack of time to await favourable conditions for astronomical fixes. Nevertheless in the winter months the scientist must tend to hibernate, whilst the surveyor is fully occupied.

The Canadian Northwest Territories are inhabited by the Eskimo, and where there is a reasonable possibility of being able to get in an annual stock of supplies the Hudson's Bay Company have established fur-trading posts. The expedition was able to make full use of the facilities provided by the Company; arrangements were made for most of the supplies and equipment to be carried on their boats, and by employing various posts as stepping-stones, the need for a permanent base was eliminated. In April, 1936, the expedition assembled at Churchill on the west coast of Hudson Bay, which is now connected by railway to the prairie provinces, enabling wheat to be shipped to Europe by a short sea route during the short navigation season in Hudson Strait.

At Churchill our 30-foot whaleboat was built by a Norwegian and christened the *Polecat*. It was considered that a boat of this size would be most suitable in ice conditions, as it would be small enough to take shelter behind a large mass of ice or in a small bay in an ice-pan, and light enough to be hauled up on to a pan if surrounded by closing ice; yet would be able to take the equipment necessary for a summer, and sufficient food to enliven the main diet of the meat of the country. It was fitted with a 30 h.p. Universal marine engine, which was sufficiently uncertain to ensure that life was never dull whilst dependent on it. It was the proud boast of the manufacturers that the cylinder head was secured by a larger number of bolts than in any other make. The expedition entirely failed to appreciate this feature, although they did in time become fairly efficient at removing the head. The main carburettor block, on the other hand, was supported from its head by a single bolt, which soon wore out the cast-iron threading on which it was dependent. Originally equipped with eight jets it finally functioned on three, and was held together by solder, wire, string, adhesive tape, sealskin line, and two sorts of glue. Air went in at a number of unauthorized places, and petrol came out at others. The consumption of sparking plugs was considerable, particularly in the fall, when everything on

board remained wet and salty, and the temperature was low. The gear lever soon succumbed in a battle with a rope fender, and a walrus tusk, carved to fit the stump, proved the most satisfactory substitute.

Sails were fitted, but the *Polecat* was flat-bottomed and would do little but run, and except on one occasion, they had been little used when the mast was carried away. The fo'c'sle was 9 feet long with a triangular floor space 5 feet wide at the entrance, and 3 feet high, with lockers beneath the floor, and in this cubicle five people on occasion cooked, ate, and slept. Amidships the cargo was packed and covered by a tarpaulin which clipped down on to the gunwales, and on this the team of twelve dogs lay, making a top-heavy but surprisingly docile supercargo. Astern was towed a 20-foot freight canoe, a seaworthy craft capable of carrying 1,500 lb. of cargo. An 8 h.p. Johnson outboard motor was carried for use either in the whaleboat or canoe. An open boat did not prove satisfactory, as the cargo remained wet and scientific equipment and specimens degenerated, whilst the shortage of space was acute. A rather larger, decked boat, such as a 3-ton Peterhead which is used in several places in the Arctic, would have been preferable.

The expedition camped in their 15-foot Everest tent, which, except for the zip-fastener door, proved excellent. By the end of April the ptarmigan migration was in full swing and the ornithologist had plenty of work. Some dogs were purchased, and those new to the game were able to try their hand at driving, several short trips after seal being made. It was hoped to start at the end of May and go north along the outer edge of the sea-ice. Calm weather is expected at this time of year, and there is perpetual daylight, whilst with the floe still fast to the shore there is less drift-ice to contend with. The expedition engineer became quite ashamed of his continual visits to the elevator workshop, each time with a different part demanding repair or replacement. One night the boat was very nearly lost soon after launching. It was anchored to the shore-ice near the mouth of the Churchill river, but the river-ice above was rotten and showed signs of breaking. It was thought advisable for a picket to sleep on board in case of trouble. The break came late one evening, and enormous pieces of ice crashed downstream carrying the boat with them. The duty picket spent a harassing night amongst the ice, but brought the boat safely in to dry land in time for breakfast.

Despite the warnings of the local prophets as to the earliness of the season, the expedition got away at the beginning of June. At that time the party consisted of T. H. Manning, leader and surveyor; P. D. Baird, geologist and engineer; R. J. O. Bray, ornithologist; R. G. M. Keeling, doctor; G. W. Rowley, archæologist.

A rapid and uneventful passage was made to Chesterfield Post,

300 miles farther north. The ice-bridge across Roes Welcome sound, between Cape Fullerton on the mainland and Southampton Island, forms two years out of three. The conditions required are a cold spell coincident with neap tides and still weather in January or February, when there is sufficient drift-ice in the sound. A solid block between the two shores may then form and given a few days of these conditions the block will remain solid well into June. When this bridge is not formed there is a constant stream of drift-ice carried down by the strong current, and as this happened in 1936, the expedition had to contend with a large quantity of ice instead of being able to cross comfortably on the lee side of a solid floe. The crossing was accomplished through leads of open water, although the course was chequered and there were some anxious moments. On one occasion the stores were landed on an ice-floe and a start was made in hauling up the boat when the emergency passed; fortunately so, as it had become evident that to pull up the boat with the inadequate tackle carried would be almost impossible.

Bray had decided to spend the summer on the low limestone marshland at the mouth of Boas river in the Bay of God's Mercy. This locality is one of the two known breeding-grounds of the blue goose, and Bray hoped to make a thorough study of this bird from the mating season until the goose again migrated south. He was landed there in the third week in June, by which time the thaw had set in, and all the low-lying ground was covered by snow-water and slush, whilst the ice-floe had started to break out. There was one solitary patch of grass the size of a table-cloth rising above the water, and on this Bray's tent was pitched. The expedition was anxious to push forward whilst the weather remained favourable, so his equipment and summer supplies were dumped on the ice-floe and the *Polecat* departed. There was a steadily increasing channel of water between the store dump and the shore, and Bray had strenuous work to get his stores to safety. It was a race against the channel, which steadily grew, and finally he found himself out of his depth, and was forced to abandon the last few loads.

The rest of the expedition remained together until August. Camps were made at Nukshanngnaq and at Ranger Brook, named after the species of seal which frequents it, whence Baird made a trip into the Nuvudlik, a range of peculiar shed-like limestone hills; also at Walrus Island. At these camps astronomical and magnetometer fixes were obtained, and sites of Eskimo houses were excavated by Rowley.

Southampton Island was formerly inhabited by a distinct group of Eskimo who were whale-hunters. These people, unlike other Eskimo, lived in houses built of stone, turf, and whale-bone. Little is known of them except that they were looked down upon by the mainland Eskimo, who considered them dirty and rather stupid,

and they died out some forty years ago. The present Eskimo on Southampton Island are Aivaliks from Repulse Bay and Baffin Islanders from Cape Dorset, the latter having been moved in when the Hudson's Bay Company established a post there some fifteen years ago. Dr. Mathiassen, of the Fifth Thule Expedition, spent a few months on Southampton Island in 1922–23, but was unable to excavate because the ground was frozen; Rowley found much to keep him busy.

The existing map (*Geogr. J.*, 88 (1936), 288) shows Walrus Island some 20 miles out of position, and a stay was contemplated sufficient only to obtain the necessary astronomical fix and a supply of dog food. These tasks were both accomplished and preparations had been made for departure when a sudden storm brought in a sea and swamped the boat. With great difficulty the magneto had been persuaded to spark again when the elements decided that a second swamping would be salutary. Both the magneto and its spare number gave up struggling. As the *Polecat* would only sail before the wind, it was necessary to wait for a southerly breeze to carry the party up South Bay to the H.B.C. post, where contact with the *Nascopie* was to be made. Tea and tobacco were the only luxuries of civilization remaining unconsumed, and the food problem was simple. Walrus and little auk were the two alternatives, the walrus becoming higher day by day. The equanimity of the party was disturbed because no one knew when the *Nascopie* was scheduled to arrive at the post, and opinion varied as to which would arrive first, the ship or a favourable breeze. On August 13th, after a fortnight's delay, the breeze arrived, and the *Polecat* ran before it up South Bay, bringing twelve months' news of the outside world to Coral Harbour, whose inhabitants learned that for many months they had been unwitting subjects of a new king.

The delinquent magneto was entrusted to John Ell, the leading figure of Southampton Island and one of the two Eskimo recipients of the Jubilee Medal, and he gave a good example of Eskimo intelligence and dexterity by restoring it to a working order. John Ell had many years previously been employed by the R.C.M.P. on the mainland, who had renamed him after John L. Sullivan, the boxer. He was a pure-blooded Eskimo, though he maintained that his father was Captain Comer, a famous whaling skipper. A curious trait of the Eskimo is the willingness to claim descent from a white man, for they have no special respect for him as such, looking upon him as one who must be kindly treated since he is rather child-like and loses his temper very easily. To trace their relationship one to another is to attempt an insoluble puzzle. They are devoted to children without apparently reserving a special affection for their own, and parents will often bring up a family of adopted children, allowing their own to be adopted by others. Although the word

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The "Polecat" in Duke of York Bay, September 1930.

Polecat Harbour, Frozen Strait, October 1930.

The dismasted "Polecat" on the north shore of Frozen Strait.

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"husky" is generally understood to denote the Eskimo dog, in the country it denotes the man, and the dog is called a dog, there being but one variety.

The *Polecat* had beaten the *Nascopie* into Coral Harbour by nearly a week, and the south-east wind had brought in a quantity of drift-ice. A south-east wind in South Bay will bring ice from Foxe Channel round the shores of Bell Peninsula, and if the wind holds it will pack up towards Coral Harbour. The Eskimo welcome this; the walrus follow the ice, as they like to scramble out of the sea and bask on the pans, and dog food is then easily acquired. In previous years the ice had packed in so that the *Nascopie* has been unable to reach the post, but in 1936 it was not thick enough, and she arrived on August 24th, piloted as usual for the last few miles by John Ell. She remained for fourteen hours during which the year's renewal of stock, handing over of furs, auditing of books, and other business was transacted.

Keeling was due to go out on the *Nascopie*. Two days before he left he had professionally assisted in a maternity case, and in appreciation the proud father had presented him with a handsome pair of white whale-skin boots. His place in the expedition was taken by Lieut. P. M. Bennett, R.E. Bennett had brought out a wireless transmitter lent by the Marconi Wireless Telegraph Company, but the cargo space of the *Polecat* was so limited that it was necessary to leave the rather bulky equipment behind at the post. It was proposed that the equipment should be transported to Baffin Island on the next year's ship, where it was hoped to make use of it.

Three days after ship-time the *Polecat* left Coral Harbour with Manning and Bennett on board. Baird and Rowley remained and later accompanied an Eskimo caribou-hunting party to Coats Island, some 90 miles farther south. Caribou was until recently plentiful on Southampton Island, but now there are only a few animals left, and a party goes to Coats Island every possible summer to get a supply of this delicious meat and the essential skins. There are some old Eskimo dwelling-places on Coats Island which Rowley was anxious to dig. Unfortunately this trip was accompanied by bad luck. The start was delayed by bad weather and soon after they reached the northern end of the island the Eskimo party succumbed to influenza. An epidemic is always to be expected at an Arctic post shortly after ship-time, and all the population, white and husky, go down. In the pure arctic air one loses the degree of immunization that comes in civilization from normal existence amongst disease germs, and on coming into contact with a carrier from outside one falls an easy victim. When an Eskimo gets ill he loses all zest for life and his one desire is to return home; so the party returned to Coral Harbour. Rowley was able to do some more excavating, whilst Baird collected a team of dogs and made

preparations for their journey across the island to rendezvous with the *Polecat*.

The *Polecat* had had some difficulty in getting clear of the pack-ice, a good deal of zigzagging and ramming and pushing being necessary. One often had to jump off the boat and climb to a lump of ice many yards away, and then push and cut, and persuade the lumps to close in to one another, leaving a narrow channel through which to manhandle the boat. There was a boat of Eskimo, off on a walrus hunt, leaving at the same time, and the two crews were able to render mutual assistance to one another. It was important to get to Bray as soon as possible as he was likely to be near the end of his food supplies.

The limestone coast of Southampton Island is practically devoid of shelter, and the water is very shallow for many miles out to sea, there being banks and rocks just hidden below the surface of the water. The *Polecat* reached the vicinity of Bray's camp on the afternoon of the second day and went firmly aground about a mile out from the coast. This was serious, as it was the last of the spring tides and the following high tide showed no signs of refloating the boat. Manning waded ashore at low water and located Bray, who had established two camps, the main one with most of his specimens being some miles farther along the coast. A strong inshore wind increased the effect of the next high tide, and the combined efforts of the three men were sufficient to get the boat into the deeper water. The next two hours were spent in a gluttonous feast for Bray's benefit, of which Christmas pudding and rum, butter, cake, and chocolates were the main components. The camp was then struck and the boat moved down the coast opposite the second camp, where she promptly went aground, again on a falling tide, this time on a sharp ridge of rock amidships, on which she was left uneasily balanced with the bows several feet high in the air and the keel ominously bent. Strenuous efforts were made to right her, but it was found that the only practical course was to pack up the keel on either side of the rock, thus distributing the weight over a greater length, and await the next tide. The cases of skins and tins of pickled specimens were carried aboard and the *Polecat* sailed out of the Bay of God's Mercy, whilst overhead circled skeins of blue geese making preparations for their long journey to the Mississippi delta.

Having obtained an astronomical fix at Cape Kendall, a halt was made to obtain another fix some way up the west coast at a place where there was little shelter. An early equinoctial gale caused some anxiety; an onshore wind got up very quickly and both anchors were lost in getting the *Polecat* away. Some miles farther north a bend in the coast provided shelter, and here the boat was run ashore and made fast to a convenient rock, one of the anchors

being recovered at a subsequent low tide. Another fix was obtained half-way up the Welcome coast at the mouth of a small river, in the creek of which the boat remained for ten days on account of the untimely ending of the spring tides. Some deer were sighted on a low limestone plateau and were strenuously but unsuccessfully hunted; there had been little meat available for some time, the larger birds having migrated, and seal hunting having proved a failure.

Whilst still some miles south of Cape Munn thick fog and snow-storm were encountered and the boat was soon among drifting ice. A strong onshore wind made it advisable to take shelter in a small bay, but the wind changed, and with the anchor dragging the *Polecat* was blown across to the opposite shore. The engine fired in the nick of time, but the canoe went the wrong side of a large piece of ice, and before it was clear boat, canoe, and ice were blown ashore and well swamped. The wind had brought in the drift-ice and formed a solid barrier some 300 yards wide across the mouth of the bay. A day's axe work at low tides, and some hours of very strenuous heaving and cutting at high tides succeeded in clearing the way to the open sea.

An astronomical fix having been obtained at Cape Munn, the *Polecat* passed through Comer's Strait, which separates Southampton Island from White Island, whose steep granite hills in their fresh snow covering were a pleasing spectacle after the barren limestone flats of the former island. This channel had an evil reputation in whaling days and was supposed to be liable to whirlpools at certain tides, but on this occasion proved well-behaved, and the *Polecat* safely entered Duke of York Bay. This bay was visited and named by Parry on his second expedition in 1821, and he described it as one of the finest natural harbours in the world; unfortunately it is icebound for ten months in the year. It was soon apparent that there was plenty of ice in the bay, but good progress was made through the leads. There were many seal, both square-flipper and netchek, on the ice, and a large polar bear was shot. Duke of York Bay is seldom visited by the Eskimo, who hold it in evil repute, but it is a fine hunting ground. The night was spent amongst the ice and proved a very cold one. The following morning the open leads were covered by an inch layer of new ice, and as it was obvious that a further advance towards the head of the bay involved a serious risk of being forced to winter there, the idea of obtaining a fix was abandoned. A two-hours' battle with the young ice so damaged the bows that it was decided to await a favourable wind to reopen the leads before attempting further progress, but before this decision was reached an overhanging ice-arch had caught the side stay and snapped the mast into two pieces.

Baird and Rowley reached the head of the bay on the day arranged

for the rendezvous, having made a slow journey as there was little snow and most of the sledging had been over bare ground. It was now important to reach the mainland without further delay, for the fall had started in earnest and except for an hour at midday the thermometer remained well below freezing-point. The guardian angel of Duke of York Bay made a final disapproving gesture at the *Polecat*, for the painter parted after dark, and the canoe containing all the tents was carried away. The *Polecat* was now uncomfortably overcrowded with five men and twelve dogs, which had to be constantly kept away from the meat in the stem. The experiment of setting them ashore at night was unfortunate, as three ran away and failed to return. The engine on one occasion took thirty-six hours to restart.

On October 2nd a suitable harbour was found on the mainland coast, a snow-house built, and preparations begun for beaching the boat and making the journey to the H.B.C. post at Repulse Bay. The ptarmigan migration was in progress and the appetizing meat of these foolish birds proved a useful adjunct to the food store. A light sledge was built from the broken mast and other spare pieces of wood, and on October 5th the party left for the Repulse Bay post which was known to be some 60 miles away, supplies for a three-days' trip being taken. The snow was still soft, and the granite country broken and rocky, the ice on the streams and lakes was unsafe, and the sea-ice impossible. The journey took nine days, of which the dogs went without food for seven, whilst the expedition subsisted on short rations of bannock. The tents were somewhere in Duke of York Bay, and the snow too soft for building. A hole in a snow-drift with a sail cover for a roof provided the night shelter, but was very cramped. A dump was made of all but the indispensable articles, and the sledge was finally abandoned, the last day being completed without it. It proved, fortunately, to be a journey of a few miles only instead of the expected twenty. The Post manager had decided that it was too late in the year to expect the expedition, and that it must be wintering on Southampton Island; however his hospitality was more than equal to the occasion. Throughout the winter whenever any of the party were at the base, they were sure of a warm welcome from Joe Ford and as many meals as they could be persuaded to eat.

Besides the H.B.C. post, there is an R.C. Mission at Repulse Bay, and there was formerly a Revillon Frères trading post. H.B.C., having taken over the fur trade of the latter company, had surplus accommodation and were kind enough to place an empty building at the disposal of the expedition for use as a winter base. The remainder of the fall was occupied by short trips and preparations for larger ones. An astronomical fix was obtained and the surveyors practised theodolite work in the confined space of an igloo. When

the thermometer registers 70° or 80° of frost it is not possible to get satisfactory theodolite readings in the open. By obtaining astronomical readings through the roof of an igloo, additional refraction errors may be introduced, but the micrometers do not stick, fingers remain unfrozen, and one does not hurry the work to get it done.

An order for dog food had been sent in a year previously, and 2,000 lb. of Bovril Pemmican had been shipped. There was an unexpected supplement in the shape of some 2,000 lb. of salmon which was bought from Eskimo in Gore Bay, where there had been an enormous autumn run. Six hunters had obtained some 20,000 lb. of fish and were thus able to feed themselves and their dogs and obtain oil fuel throughout the winter, with plenty over for others. Nevertheless it was evident that the winter dog food was quite inadequate for the expedition, and it was decided that two should go north to Iglulik at the mouth of Fury and Hecla Strait, where a plentiful supply of walrus meat was always available.

Bray and Rowley left Repulse Bay just before Christmas, accompanied over part of their route by Manning, who carried some of their stores, and reached Iglulik in the middle of January, 1937. They later made a long trip along the south of Cockburn Land to Piling on the west coast of Baffin Island, and Rowley went on to Ponds Inlet to spend the summer excavating near there; Bray, having obtained supplies from Arctic Bay Post in Admiralty Inlet, spent the summer collecting birds at Fury and Hecla Strait. The main scientific work of the expedition was more fully described in an article in *The Times* (16th May, 1938). Bray obtained more than four hundred specimens and Rowley's collections threw further and important light on the so-called Cape Dorset culture.

It had been intended to make an expedition from the head of Wager Bay through the Back river country to King William Island and on to Boothia Felix, and an order for dog food was sent in to both Wager Bay and King William Island posts. However, a radio message was received stating that the supply boat from the Mackenzie river had been unable to get through the ice, and that the post was without supplies and could provide nothing. It was impossible to carry sufficient dog food from Repulse Bay and the trip had to be abandoned. Instead it was decided to make an overland journey to the head of Wager Bay and thence overland to the coast south of Cape Fullerton and on to Chesterfield Post to collect mail, returning along the Welcome coast.

The arctic winter begins about Christmas time, when the temperature drops to −40°F., and a steady 70°–90° of frost may then be expected for two months. The weather is normally clear and still at these low temperatures, and though there is but a few hours' daylight, travel is possible through the moonlit night. Sledging at these low temperatures is however slow work. A layer of mud about

1 inch thick and 4 inches wide is moulded on to the *komatik* (dog-sledge) runners; when frozen it is planed smooth and water is dribbled on and polished with a bearskin. If applied at the correct temperature this results in a thin layer of transparent ice which provides a frictionless running surface. Salt sea-ice and glare lake-ice will quickly remove the ice from the *komatik* runner, while the rough tide-ice at the edge of the sea and rocks concealed beneath the snow will break the mud layer; once a break is formed the remainder will flake away. It is necessary in the course of a day's run to re-ice the runners several times, whilst if the mud is broken it should be re-patched as soon as possible. Porridge can be used for this purpose if no mud is available. In the still mid-winter weather the snow is covered with a layer of frost which quickly removes the layer of ice from the runners, whilst in March and April the sun will melt the black mud with amazing rapidity.

In January, 1937, Baird and Bennett went to Ross Bay at the head of Lyon Inlet and obtained an astronomical fix. The longitude of that bay as obtained by Parry differed from that of the Fifth Thule Expedition by some 20 miles, and the correct value obtained with a wireless time signal was found to lie between the two, being about 8 miles from Parry's figure.

On February 3rd, Manning and Bennett with two sledges left for Wager Post. The ascent from Repulse Bay was gradual until the height of land about 1,000 feet above sea-level was reached. This proved to be a featureless country dotted with rocky hillocks of broken gneiss rising about 100 feet above the general level of the country. The coast between Wager Inlet and Beach Point is of a similar nature, but here the general ground-level is just above that of the sea, and from the coast there is a gradual rise inland. This land crossing coincided with a cold spell, which made the going heavy, the thermometer remaining below −50°F. The caribou is still fairly plentiful in this locality and many tracks were crossed, though none was sighted. On the tenth day Bennett's sledge broke, having got out of control on a steep slope and crashed broadside-on into a rock. It proved irreparable, and the following night several dogs wandered off. The remaining sledge had to be heavily over-loaded and made slow running. The following day a high steep range was sighted which proved to be the southern coast of Wager Bay. A descent into a steep-sided valley was made, and this swung north and ran out into a narrow bay some 6 miles in length, which in turn flowed into the main Wager Bay.

Wager Inlet is about 100 miles in length with a narrow entrance some 3 miles in width at its neck running into Roes Welcome. This channel remains open throughout the year, a great mass of drift-ice flowing in and out with the tides. Fifteen miles from the entrance the inlet broadens out into a bay some 15 miles in width, and from

Frozen Strait, with White Island in the background

Near Committee Bay, May 1937.

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Canyon river, Southampton Island.

At the mouth of Canyon river.

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this point the sea is frozen over. The southern shore is generally higher and more precipitous than the northern, and both rise from low hills at the entrance until they reach their maximum height about 60 miles west. Here there are precipitous bluffs on the southern shore rising to 1,000 feet above sea-level, whilst the peaks a few miles inland are nearly 2,000 feet high. Opposite these there is a prominent cliff of red gneiss on the northern shore, about 1,000 feet high, which forms a landmark visible from all parts of the bay. This feature, known as Mackay Bluff, is unmistakable, as it is the only precipitous bluff on the northern shore. Twenty miles west of Mackay Bluff the bay divides into two, and at the head of the southern branch are the narrows which lead into the salt-water lake near the head of which the H.B.C. Post is situated. The entrance to this lake becomes a waterfall at low tides, and the channel remains unfrozen throughout the year. The lake is about 18 miles long and 2 miles wide, but, surrounded by 1,000-feet-high hills, it appears narrower.

It was evident that the existing maps of Wager Bay were much at fault, and Bennett stayed there to survey whilst Manning made the second land crossing to Chesterfield. Bennett lived with the Eskimo who managed the H.B.C. Post, a minor outpost from Chesterfield, and did most of his travelling with Eskimo. Unfortunately the radio set had not stood the sledge journey and refused to work, so that a longitude at the head of Wager Bay was not obtained. This was particularly unfortunate, as it was apparent that the head of the bay was many miles too far west on the existing maps. Two fixes were later obtained near the mouth of the bay, and to these and to the latitude fix at Wager Post the traverses were tied.

Manning reached Chesterfield and found that they were without dog food and could only supply him with oatmeal for his dogs. He returned up the coast to the mouth of Wager, obtaining two astronomical fixes, and then made a trip into the Back river country west of Wager Post. He was short of dog-food and had continuous snow, which made the going heavy and the visibility bad, but he saw what he believed to be the estuary of Back river before returning.

By the beginning of May the bird migration had begun, snow buntings had been moving for some time, and a watch was kept for ptarmigan and duck. The seals spent the day basking on the ice in the sun, with a wary eye on the horizon, ready to slide down a nearby hole with surprising speed should an enemy betray himself. The sun very soon melts the snow off the dark rocks, and by the middle of the month it is slow work sledging in the middle of the day when the snow is slushy. By this time there is perpetual daylight and all astronomical observations must be from the sun. During May, Baird made a trip overland, crossing to Committee

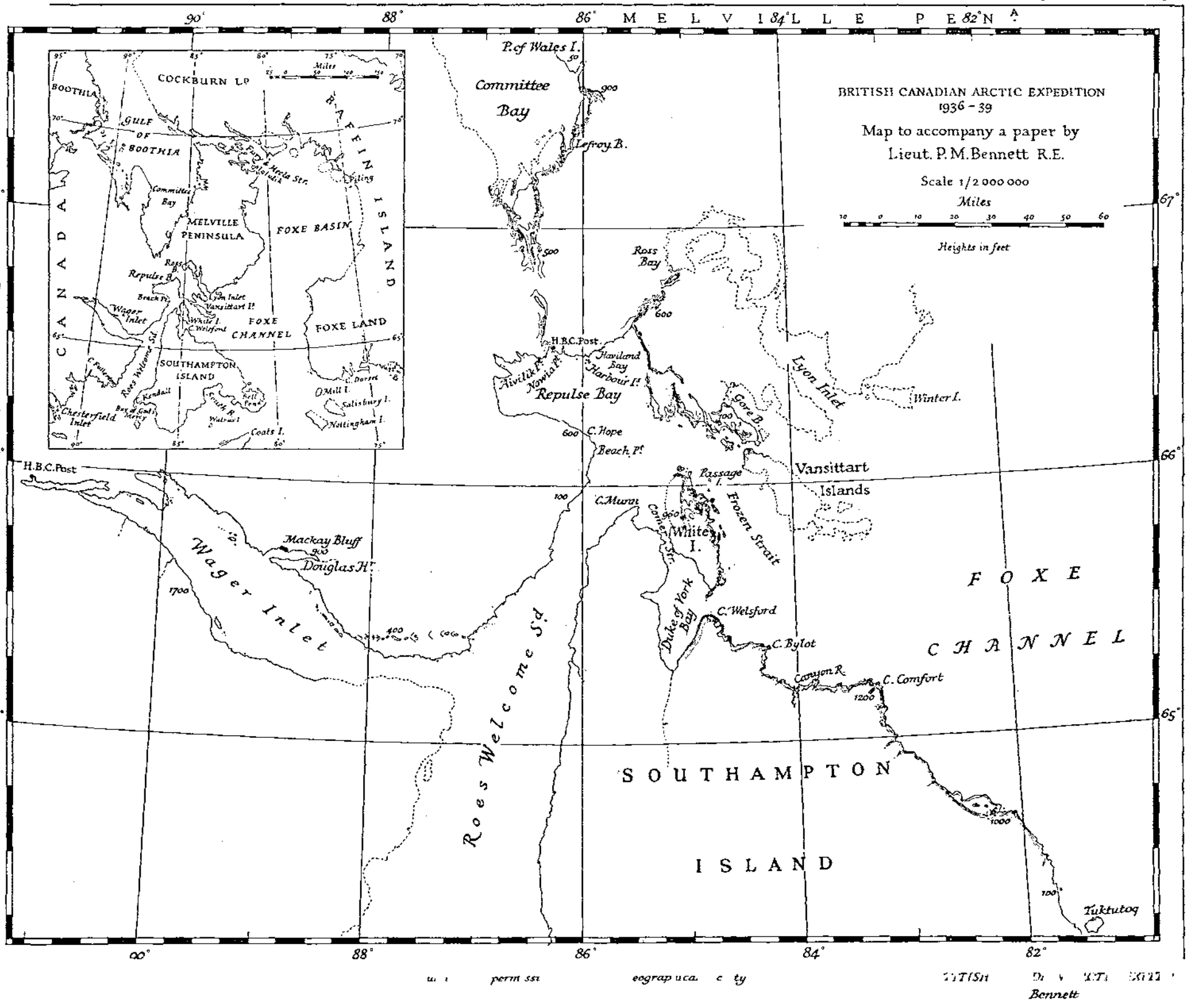
Bay and up the west coast of Melville Peninsula. This coast is a steep gneiss ridge and rises about a thousand feet, but the islands halfway up the coast are limestone. Bennett returned to Wager Inlet with a sound radio, running a traverse down the Welcome coast and up the narrows of Wager Inlet, where two fixes were obtained.

The Repulse Bay survey was completed by astronomical fixes at Beach Point and the south-east point of the bay. The whole of the coast-line is gneiss, but there are considerable variations in its appearance. Beach Point, where the bay opens out of Roes Welcome, is a low point consisting of gneiss outcrops and a series of raised beaches of broken gneiss. On rounding Beach Point a further cape with a hill some 600 feet high is seen a few miles along the coast. This is Parry's Hope's Advance; far beyond it the bay opens out to the west. The hilly coast-line continues in a smooth sweep for 30 miles until the northern shore of the bay is reached. On this shore the land is lower but more broken, whilst there are many bays and fiords. The H.B.C. Post is in a small cove sheltered by a group of islands between the points of Aivalik[1] and Nowia.[2] A dozen miles farther along the coast is a group of islands known as Harbour Islands, used as a winter base by the whalers. At the eastern end, Haviland Bay runs some miles inland and is the commencement of the land crossing to Lyon Inlet. From the head of this bay there is a straight, almost unbroken, stretch of coast-line to the south-east point of Repulse Bay, with cliffs and steep slopes to a height of 600 feet, and only at two places can a sledge get inland.

From the south-east point of Repulse Bay the coast runs east-south-east for 20 miles to Cape Montague, which is separated by a narrow strait from Vansittart Island, which consists of a range of hills running south-east for 20 miles. This stretch of coast-line forms the northern boundary of Frozen Strait, the 15-mile-wide channel that separates White Island from the mainland and belies its name by never freezing, except at its southern entrance between the south of Vansittart Island and Cape Bylot on Southampton Island, where it does freeze once in a dozen years. It is, however, crammed throughout the winter by a mass of broken ice moving up and down on the strong tide. The tide in Frozen Strait and Repulse Bay rises and falls by some 12 feet, which is twice as much as at Chesterfield and is presumably caused by the meeting of the tides round either side of Southampton Island. The coast between Repulse Bay and Cape Montague is very broken with many islands, and a plane-table triangulation between two astronomical fixes was carried out. On this coast the *Polecat* had been left to winter, and by the

[1] Aivalik: Eskimo for Walrus Point. The Aivalik Eskimo were formerly grouped around Repulse Bay, but are now spread from Igiulik to Chesterfield and on Southampton Island.

[2] Nowia: Eskimo for gull. Dr. Mathiassen excavated on this point.


BRITISH CANADIAN ARCTIC EXPEDITION
1936 - 39
Map to accompany a paper by
Lieut. P.M. Bennett R.E.
Scale 1/2 000 000
Miles
Heights in feet
COCKBURN LP
BOOTHIA
GULF OF BOOTHIA
BAFFIN ISLAND
MELVILLE PENINSULA
FOXE BASIN
FOXE CHANNEL
FOXE LAND
SOUTHAMPTON ISLAND
CANADA
P. of Wales I.
Committee Bay
Lefroy B.
Ross Bay
H.B.C. Post
Haviland Bay Harbour Pt
Aivilik R.
Nowia Pt
Repulse Bay
C. Hope
Beach Pt
Lyon Inlet
Winter I.
Gore B.
Vansittart Islands
Passage
C. Murat
Frozen Strait
White I.
Mackay Bluff
Douglas Hr
Wager Inlet
Duke of York Bay
C. Welsford
C. Bylot
Canyon R.
C. Comfort
Roes Welcome Sd.
SOUTHAMPTON ISLAND
Tuktutoq
90°
88°
86°
84°
82°
67°
66°
65°

Bennett

beginning of June preparations were being made to get away. A visit was made to Parry's Winter Island and a fix obtained to check his longitude.

June is quite the best month in the arctic. Everywhere is the tinkle of melting water and the *chic-chic-chi* of the Barren land squirrel, who sits bolt upright on a pointed stone to bask in the sun. Where but yesterday was a patch of snow there is a clump of purple saxifrage, and this is soon joined by many other flowers. The birds lose no time over their family rearing. On June 19th a clutch of young longspur several days old was found. In July, however, one is tormented by myriads of mosquitoes, and by August one feels that a snowstorm may be expected any day.

For eight weeks the expedition remained on the north shore of Frozen Strait, and never had a chance of crossing. The ice-bridge farther down the Welcome again proved itself unfriendly, for this year it formed and delayed by many weeks the southward flow of the drift-ice. A forced delay of this nature is very exasperating, for one cannot go far from the boat in case a sudden storm should temporarily open up a lead. This eventually did happen, and after one false start, as a result of which the *Polecat* remained some twelve hours in the drift-ice protected in a small cove in an ice-pan from the pressure, a crossing was made to the north-western end of White Island. A few hours later the ice again closed in, and although progress was made a few miles down the coast, the boat again became ice-bound in White Whale Sound and remained for ten days. However, Parry's Passage Island which had disappeared from the modern map was re-established, and the map of Frozen Strait completed by a survey of the White Island coast and an astronomical fix.

On August 1st another storm cleared the ice off the shore for a few days, and a crossing was made to Cape Welsford on Southampton Island, where a fix was obtained. The *Polecat* reached Canyon river some 20 miles down the coast before the ice again closed in. After living on a diet of gull for a fortnight, a net in the mouth of Canyon river provided a fine haul of salmon which proved an excellent change of diet. An astronomical fix was obtained at the mouth of this river.

Baird and Bennett, who were returning home, left the *Polecat* on August 13th and walked overland to Coral Harbour, where they persuaded John Ell to take them to Chesterfield. The ice eventually cleared away and Manning was able to take the *Polecat* down to East Bay before freeze-up, and the next summer he reached Cape Dorset. Baird and Bray returned in 1938, intending to reach the west coast of Baffin Island *via* Iglulik, and somewhere on that coast they hoped to meet Manning.

REVITALIZATION OF TARRED OR BITUMENED SURFACES BY MIX-IN-PLACE METHODS USING CUT-BACK ASPHALT.

INDIA, N.W.F.P.

By "CHARLES."

THIS article deals exclusively with an operation actually carried out in Peshawar, North-West Frontier Province, and, as such, is a description of that work and is not meant as a rule laying down how similar work should be carried on elsewhere. Conditions vary in different places, but where metal and *bujri* (river gravel) are cheap the article may be taken as a guide for the type of work carried out.

The author has been faced on a number of occasions with the problem of how to deal with disintegrating tar and bitumen miles laid in the earlier years when such processes were first applied. It appears that in the North-West Frontier Province (and quite possibly in other parts of India, too—though the author has no knowledge of this) such surfaces often break up badly. The probable reasons for this have been looked into in detail by the author ; they are numerous and open up a problem quite separate to the subject of the article. The chief reason appears to be overheating of the binder, while laying, by an ignorant staff. The fact remains, however, that the binder loses its viscosity (perhaps better described as its elasticity), dries out and breaks up under traffic into dry pieces which powder easily in one's fingers. When this starts, the road surface rapidly disintegrates, forming many pot-holes.

The question then is—what should be the remedy or remedies ? They are numerous but the four main ones may be described as :—

(1) Removing the road surface, re-metalling and surfacing.
(2) Scraping off the top surface, levelling up the existing metal by adding very small quantities of half-inch gauge metal and surfacing.
(3) Keying the existing surface (or removing it completely) and adding a pre-mix carpet.
(4) Adding a mix-in-place process to the existing surface, having first filled in the pot-holes thoroughly.

Processes 3 and 4 should only be applied when the engineer in charge is quite satisfied that the material in the existing surface

(this does not include the road base and the old metal below the surface, each of which is assumed to have reached its final settlement) will bear the pressure of the traffic as applied to the new surfaces to be added, *i.e.*, he should be quite certain that the old surface will not crush under load and so cause waving and depressions in the new surface. If the latter occurs the life of the new surface is obviously shortened.

Photo 1.

Saddar Road, Peshawar. Disintegrating Surface before mix-in-place was applied.

Concrete is definitely not mentioned because, unfortunately, it is too expensive for the North-West Frontier Province—whose finances are meagre.

The article deals with the Saddar Road; this runs through the shopping centre of Peshawar Cantonment. The average daily intensity of traffic is about 200 tons per foot.

This may not appear a large figure but, in actual fact, owing to its continual stopping and starting when visiting shops, the traffic does exert a very much higher road-wearing factor than a similar intensity would on an open road. In addition, various building operations seem always to be in hand in the near-by bazaar and a considerable number of heavily-laden bullock-carts (with narrow wheels) carrying bricks pass to and fro.

In 1933-34 the surface was re-treated with a cold bitumen emulsion; the blinding used was half-inch local nullah *bajri* which is cheap and also hard-wearing. This stood up well for two years but, in 1936, the surface began to show signs of wear and patch

Revitalisation of tarred or bitumen surfaces photo 1

repairs became necessary. These patch repairs unfortunately could not keep up with the wear and early in 1937 it was obvious that special repairs were necessary.

After due consideration it was decided that a mix-in-place treatment would be the most suitable on the grounds that other processes, like re-metalling, would take too long and would, therefore, interfere too much with the shopping traffic.

Work was carried out during the end of September and the beginning of October, 1937. The weather was fine with no rain at all. The average maximum day shade temperature was 94·5°F.

Before the materials were collected at site, it was decided to order a special drag broom, which latter is essential in the process. It has been found from past experience that locally-made drag brooms are not efficient, but a very suitable one was procured from Cawnpore, *vide* Plan. It is interesting to note that the brushes are very easily replaced by virtue of the fact that they are bolted into the cross-beams.

First, the road surface was thoroughly well cleaned and, concurrently with this, all depressions in the surface itself and all pot-holes were cleaned out. They were then painted all round with cut-back Asphalt. The latter material is a proprietary article which is applied cold. After this application, the depressions and pot-holes were filled and rammed up to the existing road surface level with $\frac{3}{4}$-in. gauge chippings mixed with crushed stone and cut-back Asphalt at the following rates :—

Half cubic-foot chippings broken from 6-in. blue limestone river boulders.

Half cubic-foot crushed stone. This was obtained from the small pieces which came from the breaking of the chippings. About $\frac{1}{8}$-in. to $\frac{1}{4}$-in. gauge.

Four lb. of cut-back Asphalt.

The road surface was now sufficiently level for the whole of it to be painted with cut-back Asphalt prior to the addition of the stone material for the mix-in-place. The cut-back Asphalt was applied at the rate of 25 lb. per 100 sq. ft. The work was done in strips of 150 ft. at a time for the whole width of the road which is 16 ft. When this painting was complete, $\frac{3}{4}$-in. gauge chippings were spread at the rate of 4 cu. ft. per 100 sq. ft. of the road surface.

While this was being done, a second length of 150 ft. was being painted similarly to the above. This was completed with chippings in due course, making a total of 300 ft. ready for mix-in-place work.

The 300 ft. was then subjected to the drag broom, which was originally drawn by a motor-car. The object of this was to demonstrate to the steam road-roller driver how the drag broom should be

applied, as it is essential to impress on the workmen that the drag broom must neither be drawn too quickly nor jerkily. After a short demonstration the drag broom was attached to the steam road-roller.

The object of the broom was to turn over these chippings on top of the painted surface until such time as they became fairly coated

Photo 2.
Finished surface. Saddar Road, Peshawar.

with the cut-back Asphalt; this is recognizable, as it has been found that with the quantities applied this occurs when the whole of the chippings appear black. While this is being done, the effect of rolling is so slight as not to compact the material until it has been properly coated. When this occurred, light rolling was started; this was just sufficient to compact the material slightly.

When this rolling was complete, the crushed screenings from the chippings, together with ½-in. *bujri* (approximately at the rate of half the quantity of chippings already put on) was sprinkled over the road surface with a view to filling any remaining voids. When this had been done, further drag-brooming and hard compact rolling were carried out simultaneously.

This was the first day's work. On the next day the surface was blinded with coarse sand, which was rolled in tight and the road was immediately opened to traffic.

Rolling in each case was done with a 10-ton roller.

The work was continued throughout the whole length of the road, which was 4,700 ft.

Revitalisation of tarred or bitumen surfaces photo 2

A small point which might be of interest is the following :—

In one portion of the road, as it existed, the camber was excessive and to get rid of this the ¾-in. gauge chippings were increased from 4 to 6 cu. ft. per 100 sq. ft. with the corresponding amount of cut-back Asphalt and the extra thickness was laid on the outside edges of the road. Drag-brooming and rolling was applied as before and the surface was flattened successfully to counteract this camber.

In conclusion, it has been found that in Peshawar District this type of work is very much cheaper than re-metalling and surfacing or than using a ¾-in. pre-mix carpet.

COSTS.

1. The cost of ¼-in. *bujri* per 100 cu. ft. is .. .. Rs. 10/-
2. The cost of ¾-in. chippings per 100 cu. ft. is .. Rs. 15/-
3. The cost of coarse sand per 100 cu. ft. is .. .. Rs. 8/-

For a 16-ft. wide road the comparative costs are :—

1. Mix-in-place .. .. Rs. 6/- per 100 sq. ft.
*2. Re-metalling and surfacing (2¼ in. consolidated) .. .. .. Rs. 7/- per 100 sq. ft.
3. ¾-in. pre-mix .. .. Rs. 7/8/- to Rs. 8/- per 100 sq. ft.

The work has been extremely successful but the author would like to state here that there are certain points which need careful attention. They are :—

1. The drag broom must be efficient.
2. The material must be thoroughly well mixed up before final rolling.
3. No dry patches must be left on the road.
4. If there is any tendency for bareness to occur in places whilst drag-brooming, the work must be stopped and such places must be painted with cut-back Asphalt and additional chippings and *bujri* put on before the work is allowed to continue.

PHOTOGRAPHS.

Photograph No. 1 shows the road surface as it began to disintegrate. There is only one pot-hole shown ; it is in the centre of this photograph. This was about 6 in. deep at the time. No other photographs are available to show the state of the road when work was commenced.

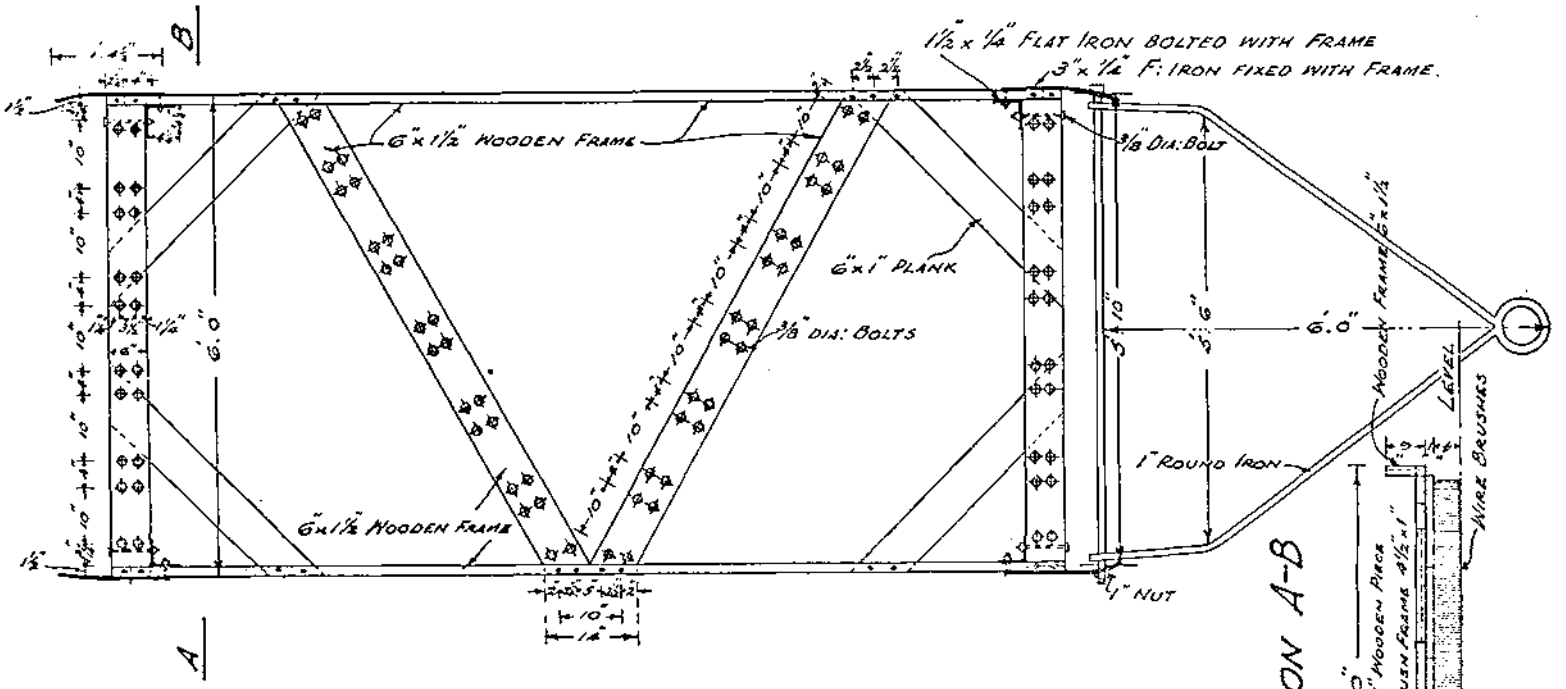
Photograph No. 2 shows the finished mosaic surface which is standing up to traffic very well. This photograph was taken seven months after the work was completed and considering the traffic going over this surface it has stood up very well indeed to wear.

* The cost only refers to remetalling and one coat of surfacing. The normal process is to apply a second coat six months after the first and so a truer cost for the finished road would be Rs. 10/- per hundred sq. ft.

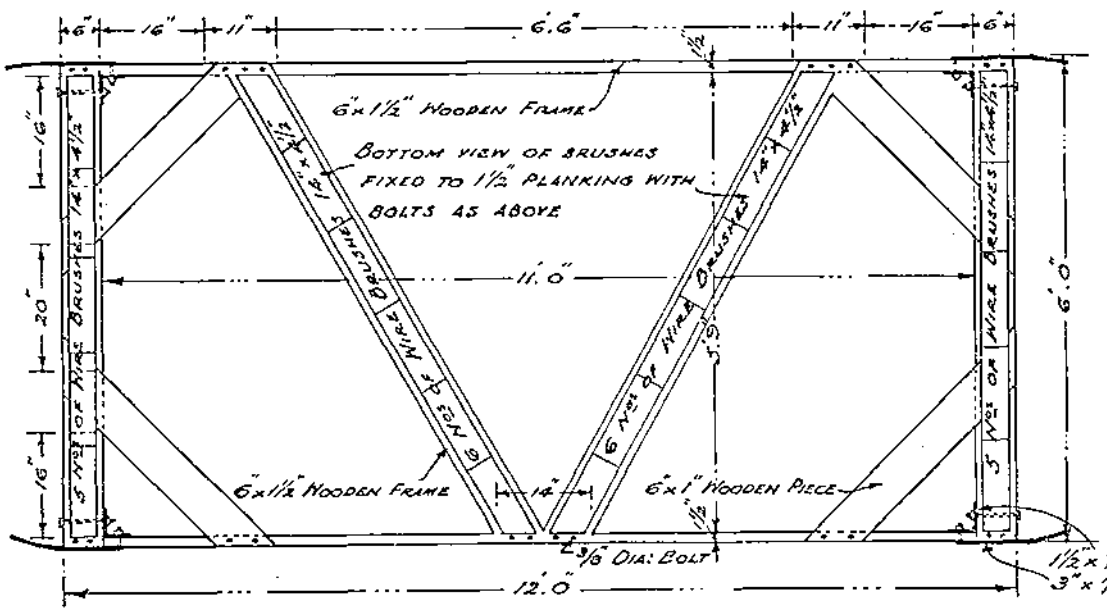
ROAD DRAG BROOM.

SCALE. 2 FEET = 1 INCH.

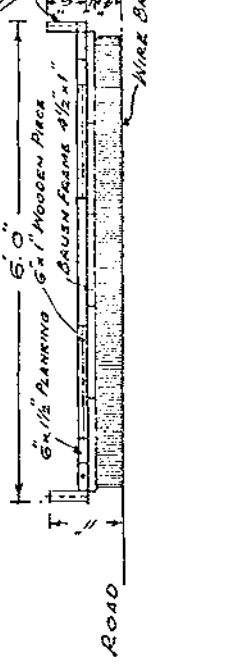
TOP PLAN



BOTTOM PLAN



SECTION ON A-B



MAKING SAILS.

By O-B.

I HAVE never met another amateur sailmaker. Making efficient sails is usually regarded as a kind of magic which responds only to the wand of Mr. Ratsey and his fraternity. Books on sailmaking are discouraging, very vague about the principles involved, and at best give a few rule-of-thumb precepts.

I first tried making sails some years ago for a *Snipe* class boat in Bangalore. The first suit of sails made " by the book " was most indifferent. I wanted to compete with people who were getting sails out from home, and I found the subject interesting. The " rule-of-thumb " methods of books seemed to lead nowhere, and I reached the conclusion that until I really understood what I was about I was unlikely to make any progress. So I abandoned books, evolved a theory on which to work and tried again. The result was a success and I have since made very successful sails for other classes of boats in England and India on the same principle.

There are probably few, if any, who have either the opportunity or the desire to try sailmaking at present. However, an outline of how the problem was appreciated and the principles deduced may be of interest and perhaps of use at some future date. The system I arrived at is visibly different from that of professional sailmakers, but it produces efficient sails—at any rate for small boats.

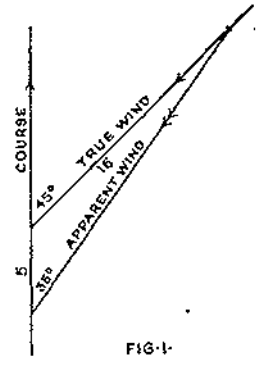
The " object " to be attained is an efficient sail. But what are the attributes of efficiency in a sail ? The sail plan of a boat gives the outline dimensions, but a sail should not set flat, and it is necessary to find out the curve and contour it should assume to give its maximum efficiency. Having done this, the object for constructional purposes can be re-stated.

From common knowledge of boats and sailing a design can be deduced as follows. It is in turning to windward that the efficiency of a sail is most marked. Therefore its curve when close-hauled is the key to its design. A small boat can expect to lay a course within 45° of the wind. With a 16 m.p.h. breeze it may do, say, 5 m.p.h. Taking the relative motion of the boat and wind (Fig. I), it will be found that the " apparent wind " makes an angle of about 35° with the boat's course. Variations in a boat's performance alter this angle of course, but not to a very great extent.

Reasoning from what seems to be a commonsense point of view,

one would expect that, to produce the greatest efficiency, the curve of the sail at the luff should " cut into the wind " and that thereafter the sail should gradually divert the wind dead aft. That is to say, a tangent to the curve at the luff should be the line of the apparent wind, and a tangent to the curve at the leech should be parallel to the boat's course. In any case it seems evident that near the luff the sail should not, and apparently could not, belly out beyond the wind line, and likewise near the leech it should not belly out beyond the course line. Conversely, there seems to be no particular reason why a flatter sail should give more efficiency.

When sailing close-hauled it is no use sheeting the boom too hard amidships or the boat goes dead. A boom of, say, 10 ft. long should



FIG·I·

be a foot to 18 in. to leeward. That is to say, the angle it should make with the boat's course is from 6° to 8°. The maximum angle between the wind and a chord of the sail may thus be taken as 27° (35° minus 8°). Higher up the sail this angle diminishes, as the sail takes a twist by the leech sagging to leeward under the force of the wind, until near the head it is probably only 5° to 10°.

It is now possible to draw a series of triangles OCB (Fig. II) for sections of the sail at various heights within which, if the foregoing ideas are correct, the curve of the sail should lie. It is commonly accepted that the curve of a sail should be greatest in the first third, and that it should flatten out towards the leech. From the two limiting tangents sections of the sail can be drawn in with a flexible ruler. Near the foot of the sail it is the course line which limits the depth of belly in the sail, and near the head it is the wind line. From drawings made in this way, the belly in the sail works out to 1/14th to 1/16th of the chord. Manfred Curry, in his book on *Aerodynamics of Sail*, states that a belly of 1/12th to 1/16th gives the best results. It is thus pretty certain that a sail made to take a belly of 1/16th of its chord will prove efficient, and a commonsense (though not exactly scientific) reason has been adduced to show why it should be.

The " object " can now be re-stated as the construction of a sail which will, when full of wind, assume and maintain a belly of 1/16th of its chord with the maximum belly in the first third.

Obviously the first factor to consider is the distribution of the wind pressure on the sail. The term " pressure " includes " suction "

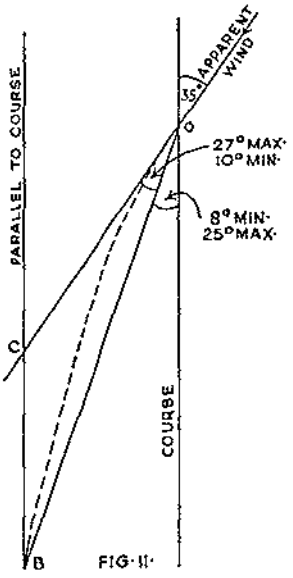


FIG. II.

on the lee side, for, as is well known, this is what produces the majority of the effort.

Manfred Curry gives a curve of the form shown in Fig. III for the distribution of pressure on a horizontal section of a sail. This is

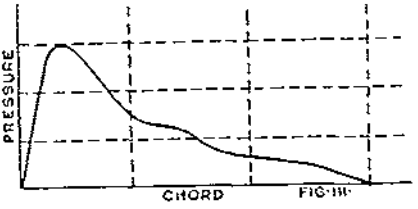


FIG. III.

similar to the curve I deduced from a study of the pressure curves for aircraft wings. The distribution of pressure over the height of a sail is roughly proportional to its width, but pressure diminishes at the head and foot owing to the wind eddies formed there.

Other factors to be examined are the inherent properties of the material of which the sail is to be built—sailcloth.

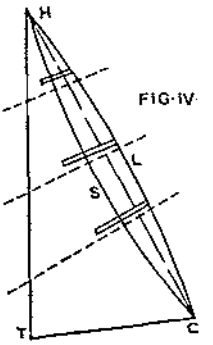
The cloth is flexible ; therefore it can only resist the load of the wind by being maintained in tension.

The cloth is composed of threads woven together ; tension in the cloth means tension in individual threads.

By correlating deductions made from the above factors a principle may be arrived at upon which to construct the sail.

The form of the curve in Fig. III suggests that if the wind load could be taken primarily by tension in the threads of the canvas which run between the luff and the leech, the sail would react according to this pressure curve. The actual curve is an unevenly loaded catenary, an approximation to which can easily be obtained by cutting out in cardboard the pressure curve shown in Fig. III, cutting the cardboard into strips, threading the strips on cotton, and hanging the cotton between pins. The result is so remarkably like the designed curve that it seems the obvious line for investigation.

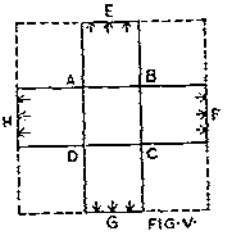
Superficially, the idea of taking the load on the sail by tension between luff and leech seems fantastic. The problem can be solved by making use of another unevenly-loaded catenary curve, this time based on the vertical distribution of the wind pressure. Cut out a



piece of cardboard to the shape of the sail, cut off a bit at the head and foot to allow for the reduced pressure there ; cut the cardboard into strips at right angles to the leech, and, by hanging them on cotton as before, a curve HSC (Fig. IV) is obtained. Now if the sail be put together with the cloths of the canvas radial to the curve HSC (which can easily be done by tapering the seams) there will be a continuous band of " weft " (or across) threads of canvas which will, for practical purposes, follow the curve. This band of threads is thus arranged in the proper curve for taking a load pulling towards the luff equivalent to the vertical distribution of the wind pressure. If this band of threads (which I call the " strain line ") is itself maintained under tension, it will take up tension in the threads of the cloth which run between itself and the luff. These threads will, in turn, react according to the horizontal distribution of the wind pressure, and take up their catenary shape, which, as already shown, is practically identical with the designed curve. Provided, therefore, that the strain line can be maintained in its proper position and curvature, and the sail is cut with the right allowance of cloth between the luff and the leech to give a belly of 1/16th of the chord,

this principle of construction embodies a plan for the attainment of the " object."

It is obviously impossible to regulate the curve of the strain line solely by the sheeting of the sail. The natural tendency will be to sheet the sail home too hard, which would straighten out the strain line and pull the belly out of the sail. In a sail with a round, or " roach " leech, the fixation of the strain line can be effected by sewing upon the leech a tabling (or hem) HLC made of a separate piece of cloth whose threads follow the curve of the leech, and using the battens allowed in a sail of this shape as distance pieces. An effect rather like a doubly-trussed beam is thus produced, and the support of the part of the sail aft of the strain line is taken care of. In a sail with a straight leech and no battens, the curve is maintained by taking any excessive tension as a direct pull on the leech



FIG·V·

tabling. To prevent the strain line sagging depends, of course, on sheeting home the sail hard enough. The transverse loading of the strain line is not heavy and a " dip " of about 1/30th is enough.

Though a sail constructed on the above theoretical principle should be efficient, there are factors affecting the practical application of the principle which have yet to be considered, namely the strength of the canvas and its reactions under tension. Firstly its strength ; will the threads in the strain line take the tension imposed upon them ? In a loose-footed sail the whole of the tension due to the wind pressure is taken at the clew. This means that it is taken by the comparatively few threads of canvas which terminate at the clew. If such a few threads are strong enough there, they are strong enough anywhere else, whatever the form of sail. By sewing on suitable reinforcing pieces at the head and clew the strain line band can be made of reasonable width with ample strength to withstand the required tension. Actually the strength of the threads in the canvas is enormous.

The behaviour of sailcloth under stress can be determined experimentally. It is important to recognize the fact that the cloth is composed of individual threads, and that it is the behaviour of these threads which governs the behaviour of the cloth. To find the effect of tension a square of cloth is taken (Fig. V), a smaller square ABCD of, say, 1 ft. side is marked in the middle, and the

corner pieces cut out. It is easy enough to rig up a gadget to apply tension at E, F, G and H and observe the results. To make sure that the cloth reacts fully it should be wetted and allowed to dry several times, beaten and rubbed wet and dry—in fact treated rough. It is found that so long as the tension at E and G is roughly equal to that at F and H, the cloth *will not stretch appreciably at all.* The more the tension in one direction is relaxed, the more the cloth will stretch in the other direction, until at last with no tension on E and G, the cloth will stretch may be 1 in. per foot in the direction H–F. At the same time it contracts between E and G. A similar effect occurs if the tension is applied the other way. Stretching in the cloth comes to a sudden and definite end at a certain point, after which no reasonable tension will stretch it any further, and the cloth does not spring back or contract unless tension is applied to the other set of threads.

It is fairly clear from this experiment that the threads composing the cloth are in themselves practically inextensible. The stretch is due to the threads which are in the greater tension *straightening out.* The weave of the cloth is like the strings of a tennis racquet. If one lot of strings is cut the others can straighten out and extend. By thinking of the cloth in this way it is possible to estimate fairly accurately how it will react in the sail. As the sail stretches a certain amount of diagonal distortion of the cloth is practically inevitable. This does not appreciably affect the reactions of the threads. The essential point is to " think in threads " when estimating stretch.

In constructing the sail to assume and *maintain* its designed shape, allowance must be made for stretch. The threads along the strain line and, of course, in the leech tabling, will straighten out completely. Stretch gradually fades out towards the middle of the sail as the tension in the two sets of threads becomes equalized, until eventually a line of no stretch is reached. Forward of this line by proper cutting at the foot of the sail the tension in both directions can be maintained sufficiently nearly equal to eliminate stretch. I have not been able to produce a theory for the position of the line of no stretch. It can be varied to some extent according to how the sail is cut. My experience is that a curve from a point on the boom about 2/5ths of its length from the clew, to a point on the luff, near the head, where the width of the sail is about 1/10th of the hoist, seems to work out about right.

The principles upon which an efficient sail can be made have now been explained, with the reasons why they ought to give good results. It is beyond the scope of this outline to go into details of the application of the principles, which anyone who has the urge can work out for himself. A loose-footed sail such as a jib is made on the ordinary diagonal cut system and a strain line worked into the foot of the sail as well as in the leech. It is necessary to spend a good

bit of time at a drawing board working out just how the cloths will lie before and after stretching before attempting to lay down a sail. The stretch can be allowed for on each individual cloth, or by making an allowance near the head and clew. Either way involves certain complications. Measuring and cutting is a bit tricky, as, when the cloths go together, they will not lie flat. Sewing can be done on an ordinary G.S. Singer. The leech tabling, however, must be sewn by hand with " round " seams to ensure that the strain comes on the cloth and not on the sewing threads.

I use light wire rope for roping my sails to avoid having to make an allowance for stretching of the bolt rope. I also stretch my sails artificially before bending them. Being roped with wire they will not set properly before stretching, and during the stretching process it is easy to see and rectify any mistakes. Errors in roping, particularly, are apt to occur and make a lot of difference to the sail. The tension of the leech tabling is also tricky.

All this is quite unorthodox, but it works.

In conclusion, I should perhaps quote, from a book on amateur sailmaking, the following extracts :—

> " . . . Men who intend to race their boats have no business making their own sails unless they wish to identify themselves with that reckless group which is prone to rush in where angels fear to tread."
>
> " Sailmaking is a fine art . . . there is no substitute for experience . . . the secrets of cutting out sails properly rest securely in the heads of men who have been laying down sails for years."

A view in opposition to this is that a sail is a structure which should be " engineered " like any other structure, and built upon some principle. Given a modicum of practical craftsmanship, an amateur who understands the principles on which he is working, and their application, can turn out a very good sail. I have worked out one principle, but there are undoubtedly others, probably better and less complicated, just as there are many ways of bridging a gap.

Anyhow, making sails for one's own boat can be of absorbing interest ; to have them admired by people who reckon they know a well-setting sail is very gratifying ; and to win races with one's own sails certainly gives intense satisfaction.

HEAT INSULATION.

By CAPTAIN J. R. G. FINCH, B.A., R.E.

I.—ESSENTIAL PROPERTIES OF GOOD INSULATORS.

FUNDAMENTALLY all heat insulators depend on air as the basis of resistance to heat flow. Still air is one of the worst conductors known, having a thermal conductivity of 0·17 B.Th.U., or about half that of the most efficient commercial insulator. The degree of heat resistance, or efficiency, of a heat insulator is inversely proportional to the size of sealed air cells; in other words, the more microscopic their size and therefore the less the possibility of circulating air currents taking place in each little pocket, the higher the efficiency, providing the material itself is a fairly poor conductor. One exception is crumpled aluminium foil, which depends partly on the reflecting properties of the bright metal (otherwise a good conductor). With regard to the size of air cells, two high efficiency materials such as diatomite and compressed cork possess enormous numbers, averaging possibly 0·01 in. square, or about one million to the cubic inch, test efficiencies of which reach 90 per cent or more.

Two important factors limit the class of material and efficiency of covering:—(*a*) Working temperature, and (*b*) economic considerations.

The working temperature of the surface to be insulated has an important practical bearing, as some otherwise good materials break down and ultimately become poor insulators, above certain temperatures. For this reason cork, hair felt, wood, charcoal, etc., are usually reserved for cold surfaces, magnesia for medium temperatures and asbestos or silica compositions for high degrees of heat.

When studying economic considerations, it is generally found that the smaller the air cells the higher the cost per unit volume of covering, but the thickness is reduced for equal insulating value. For example, in the low temperature range granulated cork has relatively large air pockets, and is cheaper but of lower efficiency than baked and compressed cork slabs, with smaller air cells. In the higher range, some forms of cellular asbestos with large air cells are cheaper but less efficient than good 85 per cent magnesia, which possesses very tiny cells. The increasing use of removable sectional forms of pipe covering, with standardized thicknesses, as compared

with the older plastic compositions, has had the effect of making the true economic thickness a matter of secondary importance.

The various desirable qualities for good insulators are :—

(1) Low thermal conductivity.
(2) High mechanical strength against accidental knocks and vibration.
(3) Durability, which includes ability to withstand alternate wetting and drying ; also, no tendency to crack with heating and cooling ; and, retaining its insulating properties after continued use.
(4) Non-inflammable.
(5) Free from corrosive action on metals, *i.e.*, no acid.
(6) Low specific heat, in order to avoid excessive heat to warm the covering.
(7) Low specific gravity, in order to avoid excessive bending strains on piping.
(8) Free from moisture absorption, *i.e.*, weatherproof.
(9) Easily applied.

2.—Practical Considerations in Application.

(a) Refrigeration Plant.

The normal insulator used is compressed cork. It is fixed in place with hot pitch. In doing this no gaps must be left in the insulation whatsoever, otherwise condensation will take place and ice will form, bursting the covering.

To make sure that a good quality cork slab is being used, boil for two hours. The reason for this is that attempts are made to use again shavings, cementing them together by some artificial method, instead of the slab being held together by the natural gum that comes out in the baking. The result is neither durable nor so efficient. If the cork will stand up to this test it is all right.

For finish, and its protection, in interior work, the cork is covered with some hard-setting plaster, and painted. A bright paint finish is liable to cause condensation, and collect moisture. If this is to be avoided, a distemper finish is better.

If the pipe is to be exposed to the weather, cover it in a layer of Ruberoid and wire netting, or better, some cold bituminous compound.

The same remarks apply if cork is to be used for the protection of cold water piping, except that the hot pitch is not essential.

(b) Cold Water Piping.

This is covered either to prevent freezing in cold weather, or to prevent condensation on the cold metal surface, and the consequent mess.

Cork is the most effective covering, a thickness of 2 in. being suitable. But this is expensive, and more often compressed or hair felt is used. The former is the cheaper, but more difficult to apply at bends, etc. But it gives a better finish, as hair felt bulges.

Underneath the felting it is usual to have a layer of waterproof paper, to prevent any absorption into the covering. A canvas cover on the outside gives protection against knocks and a base for painting. Again, distemper is the best finish.

All parts of the pipe must be covered, including flanges. In the one spot that this is neglected, there will be a collection of moisture and damage to the insulation.

(*c*) *Hot Water Piping.*

In small and cheap installations felt is again used. The main difference is that instead of the waterproof paper, it is usual to have an $\frac{1}{8}$-in. layer of asbestos boarding. This is really for safety purposes, as in the event of overheating in the system it takes the first heat off the pipe, and prevents the felt catching alight.

In bigger systems 85 per cent magnesia is more usual, if possible applied in its plastic form. A common specification is $1\frac{1}{2}$-in. plastic magnesia with a $\frac{1}{2}$-in. coating of hard-setting plaster. The covering on the pipe ends in a bevel short of flanges, walls and other obstructions. The face of the bevel is finished with canvas or paint, so that the flange covering will not adhere to it.

The flange covering is a bit of a problem as it is liable to have to be removed, so it is often left out. This is inefficient, as the loss in the flange is about equivalent to the loss in 1·1 ft. of pipe. Methods of covering are: an asbestos mattress with a laced fixing, asbestos wool in a metal box, or a plastic covering which can be removed without damage to the pipe covering. The first is expensive, and readily collects dirt. The second is also expensive. The last is the cheapest and probably the best, though it has to be renewed every time the flange needs attention.

Plastic magnesia has little mechanical strength; a certain amount of adhesion can be obtained by first giving the surface a clay or asbestos wash. Wire netting is used for reinforcement in pipe diameters of 6 in. and over. The netting must be galvanized and of not too close a mesh, say $1\frac{1}{2}$ in., or it will cause a layer of cleavage. Provision must be made on occasions for fixing the netting to support angles.

A fine linen or canvas trowelled into the surface of the hard-setting plaster gives extra strength, and hides cracks. Points that are liable to be knocked should be covered with thick canvas or even planished steel.

The paint finish is quite important. Besides being used as a preservative, and a means of identification, it can hold back the

heat up to about 50 per cent of the amount that penetrates the insulation. A bright glossy finish is good, but the best appear to be the metal paints. In this connection there are two points. Because it gives a pleasant finish, metal paints are often used on radiators, with a consequent loss in efficiency. A bright finish, too, will feel hot to the touch; this is often misinterpreted to mean that it is inefficient, while actually what is felt is the heat that is being held up. A mat finish, being a good radiator, conversely, will feel cool.

(*d*) *Flue Pipes and Boilers.*

At any points where flames from the fire impinge directly on the metal, the lagging on the other side must not be in contact, but separated from it by at least half an inch. If this precaution is not taken, there will be a building up of the heat in the metal until it burns. Cases have been known of flues collapsing from this cause. A good method of obtaining this gap is to use a sleeve or sheet of expanded metal. This is held on small brackets welded to the metal surface, and gives an excellent key for the plastic.

For methods of working out efficiencies and thicknesses of covers see Appendices 1, 2 and 4. Appendix 4 gives the insulation value of a few common non-proprietary insulators. For a few notes on peculiarities of 85 per cent magnesia, see Appendix 3.

(*e*) *Building Materials.*

A selection of heat-resisting walls are given in Appendix 5. It is obviously meaningless to give a value for " K " per unit thickness, so a value for K/L is given.

The aluminium foil gives the most important result. This might well be applied to roofing in hot climates.

Coke breeze concrete is not a particularly efficient insulator, owing to its considerable density. If the wall does not have to withstand any great load, a better result can be got by the use of coke breeze blocks, made up as follows:—

Coke breeze with 5 per cent by volume cement, added as a paste in water; mix well, and make into blocks; compress slightly by any method, and allow to dry. When dry, render with 1 : 5 cement : sand. This will seal the air cells. If it is desired to add a layer of cork the slabs can either be nailed on, or fixed in 1 : 2 cement.

From tests in this country, it appears that the earth temperature is practically constant at a depth of ten feet. In fact a slight fall in temperature occurs during the summer. This suggests that in hot climates considerable heat can be prevented from entering a building through the floor if there is a sufficient verandah. This may seem obvious, but it is a point that is often overlooked. I have come across a good many cases in India.

3.—CONCLUSION.

Pipe and boiler insulation is a matter that does get its due consideration. But the mistake is still made of specifying an efficiency without giving the working temperature. Building insulation, though, is still a matter of guess-work, except in such places as the Viceroy's Residence at Delhi. Single officers' quarters have been constructed in which one has had to wear a hat during the hot weather. I have heard it said that we appear to have lost the art of building for a hot climate.

The rules of application are really simple. If a certain amount of consideration is given to them there should be some remarkable results.

APPENDIX 1.

HEAT LOSSES FROM UNCOVERED SURFACES (METAL) TO AN AIR TEMPERATURE AT 70°F.

Metal Surface Temp. Degrees F.	q/b B.T.U. Factor.	B.T.U./sq. ft./hr. Loss.
100	1·95	58
150	2·20	176
200	2·27	295
250	2·57	462
300	2·75	632
350	3·06	856
400	3·37	1,112
450	3·80	1,444
500	4·14	1,780
550	4·64	2,227
600	5·06	2,681
650	5·59	3,242
700	6·04	3,805
750	6·63	4,508
800	7·12	5,197
850	7·74	6,037
900	8·30	6,889
950	9·50	8,360
1,000	9·61	8,937

The q/b factor is used to compute the third column and produces a reasonably accurate result.

Factor × Temp. Diff. (Metal-Air) = Heat Loss in B.T.U's./sq. ft./hr.

Example.

Air at 40 F., Surface at 700 F.

Difference in Temp. 660.

Factor at 700, 6·04.

Heat Lost = 660 × 6·04 = 3,980 B.T.U's./sq. ft./hr.

APPENDIX 2.

CALCULATIONS.

Formula for Heat Loss from an Insulated Surface.

If H = Total loss of heat in B.T.U's./hr.
A = Area of Surface Insulated in sq. ft.
K = Conductivity in B.T.U's./sq. ft./hr./degree F. temp. diff. per 1-in. thickness at the mean temp. of the two faces of the Insulation. (It should be noted the heat loss does not vary only as the temp. difference, but also as the mean working temperature.)
T_1 = The internal temp. of the Insulation, F.
T_2 = The surface temp. of the Insulation, F.
L = The thickness of Insulation in inches.

Then

$$H = \frac{A \times K(T_1 - T_2)}{L}$$

For a composite covering where there are layers of different thicknesses and with different conductivities :

$$\frac{L}{K} = \left(\frac{l_1}{k_1} + \frac{l_2}{k_2} + \frac{l_3}{k_3} \ldots\ldots\ldots\right)$$

Where K is given in calories per second it can be converted to the above dimensions by multiplying by 2,903.

The efficiency of the Insulation System is then :

$$1 - \frac{\text{The Insulated Loss}}{\text{The Uninsulated Loss}}.$$

The method of working can be seen in the following example :

A beer storage room had to be designed to work at 55 F. against an outside temperature of 75 F. For a given design of insulation work out the heat load.

CEILING.

6-in. concrete, 1-in. wood, 2-in. cork slab rendered.
Area, 350 sq. ft.
T_1 at 75 F.
T_2 at 55 F.

$$\frac{L}{K} = \frac{6}{8{\cdot}1} + \frac{1{\cdot}0}{1{\cdot}0} + \frac{2}{{\cdot}29} = 8.63.$$

$$H = \frac{350 \times 20}{8{\cdot}63} = 805$$

FLOOR.

8-in. concrete.
Area, 350 sq. ft. $H = 350 \times 8{\cdot}1 \times 5 + 8.$ 1,772
Air temp., 55 F.
Earth temp., 60 F. (A constant in this country at a depth of 10 ft.)

PARTITION WALLS.

3-in. coke breeze blocks rendered, 2-in. cork slab rendered.

Area, 274 sq. ft.

T_1 at 75 F. T_2 at 55 F. $\quad \frac{L}{K} = \frac{3}{4 \cdot 1} + \frac{2}{\cdot 29} = 7 \cdot 59$

$$H = 274 \times 20 \times \frac{1}{7 \cdot 59} \qquad 717 \cdot 8$$

DOOR.

2-in. pine, 2-in. cork slab.

Area, 27 sq. ft.

T_1 at 75 F. T_2 at 55 F. $\quad \frac{L}{K} = \frac{2}{1} + \frac{2}{\cdot 29} = 8 \cdot 88$

$$H = 20 \times 27 \times \frac{1}{8 \cdot 88} \qquad 60 \cdot 48$$

BRICK WALLS.

18-in. flettons.

Area, 315 sq. ft.

T_1 at 75 F. T_2 at 55 F. $\quad H = \cdot 23 \times 20 \times 315 \qquad 1,449$

LIGHTS.

Two 60-watt lamps.

$$H = 120 \times 3 \cdot 415 \qquad 409 \cdot 8$$

AIR CHANGE.

At 50 per cent per hour.

Vol. of cellar, 2,455 cu. ft.

$$H = \frac{2,455}{2} \times \cdot 02 \times 20 \qquad 490 \cdot 8$$

Total ... 5,704 B.T.U's./Hour.

The above figures give a good idea as to the relative importance of insulation in various places.

APPENDIX 3.

85% MAGNESIA COMPOUND.

This compound can normally be supplied by manufacturers of insulating materials, and is a standard. It is used for hot-water systems and low-temperature steam piping, up to 600 F. Above this temperature it is liable to burn and lose its properties.

The drop in temperature across a section of insulation is not uniform. At 100 F. a 25 per cent drop occurs in the first inch and at 1,000 F. 80 per cent, and proportionately at intermediate temperatures. While for the next $\frac{1}{2}$-in. the further drop is only 1 and 4 per cent respectively.

The compound is held together by the 15 per cent Asbestos fibres, but if in any mass has to be reinforced by wire netting. The netting must be galvanized or corrosion will be very quick.

APPENDIX 4.

Some Values of "K" at Working Temperatures.

(*Note.*—"K" varies with the temperature at which it is working and not by a straight line law.)

Substance.	Temp. F.	K	General Use.
Baked Cork Slab at 10 lb. per sq. ft.	48 and below.	·26	Refrigeration and cold water pipes.
	86	·29	Hot water systems.
	122	·31	
	158	·33	
	176	·34	
Diatomaceous Earth at 30 lb./cu. ft.	30	·56	The base for all plastics.
	73	·62	
	162	·65	
Bitumen Covering	79	5·8	Weather-proofing.
Concrete, Rock and Hard Earth	88	8·1	Building construction.
Coke Breeze ...	50	4·1	Partition walls.
Glass Fibre ...	44	·27	
	140	·28	
Crumpled Aluminium ...	60	·3	Road tanks and where lightness in construction is required.
Foil, 1-in. thick, ¼-in. air space either side	100	·4	
	500	·7	
Spruce	80	·69	
Deal and Teak ...	80	·81	
Three-ply ...	80	·96	
Pine	80	1·04	
Oak	80	1·11	
85% Magnesia, 15% Asbestos Fibre	100	·42	
	150	·43	
	200	·43	
	250	·44	
	300	·45	
	350	·46	
	600	·56	

APPENDIX 5.

HEAT TRANSMISSION COEFFICIENTS FOR TYPICAL WALLS.

Temperature Range, 68 F. to 86 F.

Description of Wall Section.	Inches Thickness.	K/L.
One-brick Walls:		
London Stocks in cement mortar	9	0·68
Flettons in cement mortar	9	0·70
Sand-lime bricks in cement mortar	9	1·03
Cavity Walls:		
Sand-lime bricks on edge: two thicknesses with headers spanning cavity	9	0·80
Outer layer, pressed steel sheet, $\frac{1}{8}$-in. thick. Inside layer, compressed fibre wall board ...	6	0·47
Outer layer, $\frac{1}{8}$-in. pressed steel sheet. Inside layer, asbestos cement sheeting	6	0·76
Sand-lime bricks: 11-in. wall, hollow with two thicknesses tied with galvanized iron ties	11	0·72
1-in. outer slab of gravel concrete, reinforced; inner slab of 3-in. breeze concrete; cavity between	$6\frac{1}{2}$	1·0
Timber frame construction; $\frac{3}{4}$-in. weather boarding, 1-in. rough boarding; 4 in. × 2 in. studding and lath and plaster	6	0·4
Composite Walls:		
3-in. outer slab of gravel concrete and 3-in. inner slab of breeze concrete with bitumen sheeting in between	6	1·33
Two thicknesses of $2\frac{1}{2}$-in. breeze concrete blocks with 2-in. cavity filled with gravel concrete (1–6)	7	0·84
Outer slab, $1\frac{1}{2}$-in. cement-gunned reinforced concrete. Centre slab, 2-in. slab cork. Inner slab, 2-in. breeze concrete with $\frac{1}{2}$-in. plastering on face	6	0·18
Pise Walls (rammed in shuttering):		
Clinkers and lime (85 lb. of lime to $\frac{1}{2}$ cu. yd. of clinkers)	9	0·89
Peterborough Clay, 2 parts; gravel, 1 part...	9	0·95
$4\frac{1}{2}$-in. brick wall built up with reinforced aluminium foil, $\frac{1}{2}$-in. air spaces, and backed with asbestos wall board	6	0·22

THE CRUISE OF THE "HANAFIAH."

By CAPTAIN R. S. HAWKINS, R.E.

"HANAFIAH" was the name of the car—a second-hand Ford V. 8 bought off a bankrupt Chinaman in Singapore. I was searching through the car "mart" of that city for a vehicle to take the three of us —impecunious Army officers—home to England. The inevitable tout, one-third Malay, one-third Chinese and one-third pure Aryan stock, sighted me, marked me down and then approached with a grand military salute and a face wreathed in Oriental smiles.

"Want to buy a car, sir?" No pidgin lingo about him, but excellent "English School" English.

"Well, what have you got?" was my safe non-committal reply.

"Can get anything, sir; you just tell me what you want and I'll get it." This remark was accompanied by the production of a fat note-book, letters from exalted persons thanking him for buying and/or selling their cars, and a photo of himself in a group of garlanded royalty. I gave a brief description of the sort of car I wanted, naming what I considered a suitably low price.

"Have got the very thing, sir!"—another salute. "Where shall I bring her round to? Yes, can do to-morrow—what time, sir?" This with an air of being able to produce even the Governor's private car for sale if so desired. I suggested that the next morning at the Mess would be suitable.

Next morning at the Mess it was. The car, incredibly similar to what I really wanted, rolled up complete with tout, his friend, the owner, his friend and A. N. Other. After a brief examination of the car and exchange of pleasantries, I got in. With four up in the back and, as I discovered later, complete lack of shock-absorbers, we rolled and swayed merrily through the countryside. An extremely short arrangement about the price—I knocking off $50 and he adding on $10—"A little commission for me, sir"—and I agreed to buy. There was no point in lengthy arguing as the price was definitely good, and anyway far below trade prices. A delay of two days enabled me to raise the necessary cash; again the quintet appeared, fat rolls of notes changed hands, everybody shook hands with everybody else, and by writing a letter of thanks and recommendation I joined the ranks of the exalted ones.

This transaction was the result of an agreement between myself and two other officers by which we were to buy a car, fit it out and

drive home to England, using Calcutta as our starting point. Expense was a prime consideration and everything had to be done on the cheap. Over a period of two months I fitted to the " Hanafiah " an extra 30-gallon petrol tank, a tiffin box and rear trunk, lovely fat oversize tyres, and painted two large Union Jacks on the bonnet, with her name alongside each in Malayan script.

Our route was to be along normally-used routes, and we had every intention of avoiding any unpleasantness. Our plan was to ship ourselves to Calcutta and drive home through India, Persia, Palestine, Egypt, Lybia and Europe. As the time for departure drew near, we busied ourselves buying warm clothes (a hard enough job in a tropical country !), cooking-gear and various spare parts.

At last the great day arrived and I drove the " Hanafiah " to the docks to be loaded aboard the s.s. *Suisang*. It is a normal requirement that petrol tanks should be empty before loading, and being of an economical turn of mind I tried to arrive at the docks with a minimum of petrol. I was more than successful, for it ran out two miles from the docks and one hour before sailing time. I had to hire a taxi, frantically collect more petrol and drive to the docks—so far so good ; but there I found I had left an attaché case containing my revolver, passport, money and car papers in the taxi ! Fortunately the Malayan police came to my rescue, for to have a revolver floating around " on the loose " is a thing they least desire. I raced round Singapore in a police car looking for the only taxi in the world that mattered, in an agony of wondering whether to put off the trip for a week or to be arrested as a vagrant in Calcutta. By stupendous luck the taxi was found, and the case intact ; so back to the ship—twenty minutes to go—terrific crowd to see us off—beer's run out—no, here's two dozen more (from the bonded store I think)—photographers from the local paper—more people come to see the last of us—" Apa chunkel ! "—" Satu ampat jalan ! "*—now the beer has run out—and so on, to the awkward pause when the ship still doesn't sail and we stand fatuously on deck, waiting for something to happen.

* * * * * * *

After an extremely pleasant voyage, we arrived at Calcutta and slept the night aboard. Much to our surprise, the car had been unloaded overnight and our next task was to get it through the customs. How this was accomplished by myself, a representative of the A.A., Bengal, his motor-cycle, a certain amount of ready cash and infinite patience is a saga in itself. It was the most soul-destroying twelve hours I have ever spent, although I believe our

* " Apa "—What ? ; " chunkel "—combined shovel and pick used by coolies rather like a hoe ; hence " Apa chunkel ! "—What ho ! (but meaningless to a Malay) ; " satu "—one ; " ampat "—four (numeral !) ; " jalan "—road ; hence " Satu ampat jalan "—One for the road ! ! (more frightful still).

time was an all-time low record. The car lay a bare fifty yards from the outer world, but we had to push it, with the aid of innumerable assistants clamouring for *baksheesh*, at least twenty times that distance. From shed to shed, babu to official, official to babu, taking a form here, getting the "carnet" stamped there, we trundled—with an occasional jaunt into the town to find another link in the chain. Eventually we staggered exhausted through the dock gates into the big city, pushing the car before us. At last!—we were allowed to pour in the blessed petrol and start her up. Meanwhile the rest of the crew bought maps and provisions in the town, spending a carefree day with adequate meals and cooling drinks. That evening we filled "Hanafiah" up with her full complement of 40 gallons of petrol, a proceeding which caused the garage proprietor to jagger about with the internals of his petrol pump, as the scale pointer stuck at the maximum reading of 20 gallons.

The following morning we started off, full of excitement and looking forward to two months on the road. After a very slow drive out of Calcutta, owing to the narrow roads and bullock carts, we eventually reached the Grand Trunk Road. Twenty-three miles on we passed through Chandernagore, which although in British India is French territory. We thought something was odd when we noticed the Indian policemen wearing different hats! The road was good, though speed was limited by bullock carts which crawled along the central metalled portion of the road, with the drivers fast asleep. Horn sounding woke them up, but there was no saying to which side of the road they would go to let us pass. The country was dull, dusty and sun-scorched and we were glad to reach Dehri-on-Sone. Here we spent the night in the P.W.D. Rest House, cooking and eating our own supper as there were no servants.

Next morning we put the car on a truck for rail transport across the Sone River. There is no road bridge at Dehri, but a small train is always in readiness to take motor vehicles across the river. It was very hot and dusty during the daytime; shorts and shirt-sleeves were the order for dress, and frequent stops for drinks of lime juice broke a rather monotonous journey. Twelve miles short of Delhi we had our first spot of bother; accelerating away from a bridge the engine raced and the car slowed. Investigation revealed a broken transmission shaft and one flat tyre. We changed the wheel in a cloud of dust, mosquitoes and small boys, and then brought out our rope, tied it hopefully to our towing shackle and waited for a lorry. One very shortly arrived on the scene, and the Indian driver willingly gave us a tow into Delhi. The dust was bad enough a quarter of a mile behind another car, but being towed six yards behind a heavy lorry, it was indescribable. To complete our discomfort the sun was low down and right in our eyes.

The following day, with repairs to the car nearly completed and

the delightfully modern and clean New Delhi to see, our spirits revived. There was still work to be done on obtaining Afghan and Iranian visas and car permits. We had previously warned the Chief Political Officer of our requirements, and he gave us all the assistance he could. Unfortunately the Iranian Consul was away on holiday and there was some hitch with the Afghan visas, so we were advised to push on to Peshawar, and see the Afghan Consul there. Arrangements were made with the British Legation at Kabul to get our Iranian visas for us.

After a stay of two days in Delhi we continued our journey to Lahore, where we stayed the night. The following morning was quite cold, and we had our first glimpse of hills and snow near Wazirabad. We crossed the River Indus at Attock and that evening we reached Peshawar. Our first day here, being Sunday, we just did nothing, but the next day we visited the Chief Secretary, who helped us with a letter of introduction to the Afghan Consul. From him we obtained, without any difficulty, our Afghan visas. Later on, we had news from Kabul that there were ten feet of snow on the Kabul-Kandahar road, and that the route would be impassable for another ten days. Rather than wait an unknown time in Kabul we decided to travel to Quetta and enter Afghanistan by way of Kandahar. The most direct route was down the valley of the Indus over roads that were marked by very thin lines on the map, which meant, as far as I can remember, that they were "only passable in dry weather." The weather had been extremely dry and dusty, but we knew nothing about the climatic conditions of the North-West Frontier, nor that a very small rise in the level of the Indus caused floods over areas larger than Great Britain.

A few miles south of Dera Ismail Khan, conveniently shortened to D.I.K. by Europeans and natives alike, we passed unheeded the first indications of difficulties to come. The road was only *kutcha*, an unmetalled embankment over mud flats; a certain amount of water was still lying about, and there were highwater marks at fords and on the embankment to show that the road had but recently been flooded. At one place a brick and concrete bridge had been washed away, leaving the central pier standing forlornly in the middle of the river. We had no difficulty in crossing, as there were only three inches of water flowing. Further on we came to "fords," which consisted of concrete-surfaced dips in the embankment—just like Irish bridges on a very large scale. Further on still we came to a trickle of water across the road, with slimy mud on either side. Alas! This was the final warning that should have sent us tearing back to D.I.K. and safety. This little stream was the insidious forerunner of the rising water level. The belt of mud was about twenty yards wide, so we changed to our knobbly tyres, got into the car and flew at the slimy mess. With frightful bumping and jolting

the car slewed sideways, stopped and the rear wheels spun themselves into axle depth. A few passers-by gave us a helping push, but we never looked like getting the car out of the mud. Then the fun started; first with the arrival of rain, then darkness, the disappearance of our assistants and finally little pools of water were observed in wheel ruts and foot marks showing that the water level was rising. Twelve strong men, our late helpers, had failed to shift the car and they had worked willingly and well. Here were three of us left, and as there was nothing else to do, we made up our minds to shift the car or "bust." We worked for five hours in utter darkness, pouring rain and nine inches of slimy mud. We used our rope to pull forwards and backwards; we put coconut matting under the wheels; we shovelled tons of mud; we bound the rear wheels with rope to get a grip; we fell down in the mud, we pushed, heaved, struggled and swore. The "Hanafiah," grossly insulted at such ill-treatment, fighting every inch, grudgingly allowed herself to be coaxed out of the morass. The battle ended at the glorious moment when the wheels gripped and the old car heaved herself bodily out of the mess. Unfortunately, rope had wound itself round both rear brake drums and the brakes remained "hard on," so further progress was impracticable. However we were on firm, though extremely muddy, ground so we had to spend the night in the car. It continued to rain all night and the flood water rose on all sides. Creeping out at first light we found three inches of water ominously flowing past the wheels; there was water, water, everywhere and ahead of us the road appeared as a thin strip of dry land, curving away into the distance every now and then vanishing under water. We coaxed the car a few hundred yards to a dry piece of road, had breakfast and then attacked the rear wheels with a clasp knife, hacking away at the rope until they were free.

We were now facing north, the direction from which we had come, and we decided at all costs to get back to D.I.K. and safety. The first Irish bridge we reached was under two feet of water flowing extremely rapidly. We prepared to cross this, sealing up the oil filler and battery with plasticine. Before we took the plunge, however, a young Indian magistrate came through on a horse and informed us that there were four feet of water at the broken bridge. That settled it—we could not go forward or back and we decided to sleep the night in a nearby village. This was arranged for us in the village schoolroom, to the intense delight of the local inhabitants. The next day we got through the Irish bridge, after sticking in the middle, as the water swamped everything. Further on we came to a freshly-formed breach in the embankment, water was streaming through it and the sides too steep for a car to negotiate. There was nothing to do but to wait for the water to subside. I walked the eight miles to D.I.K., hired a car and drove back as far as the broken

bridge; meanwhile the rest of the crew, aided by passers-by and rewarding them with cigarettes, brought our kit from the car to the broken bridge. We then loaded the hired car, drove back to D.I.K. and spent four rather depressing days in the Rest House.

On the fourth day, the water having subsided a little, we hired a villainous gang of men and an amazing old passenger bus and struck a bargain with the foreman that for forty rupees he would get our car back to D.I.K. This was done actually without any great difficulty, although all the man-power was needed to pull us through the breach, and the bus gave us a tow through the river at the broken bridge. We spent the rest of the day washing mud off ourselves and the car, and started off the following day in better spirits on another road east of the Indus.

This road took us through dry sandy desert to Dera Ghazi Khan, our destination five days before. Near this town we crossed and recrossed the flooding Indus and its tributaries many times by boat bridges. The limit speed over bridges was 3 m.p.h. and this was enforced by a man walking in front of each car crossing. After Dera Ghazi Khan the country was mountainous and barren, though very muddy and wet with the rains. There were many fords and streams to cross, and at most of these the P.W.D. had put down 3-in. wire mesh, held to the ground by heavy stones. This prevented the road metalling being washed away by the streams, which came pouring down from the hills with every rainfall. The maximum cruising speed was about 25 m.p.h. and often we had to slow down to 10 m.p.h. to pick our way through bad going. In the evening the road took us past Fort Monroe, 6,300 feet above sea-level, and eight miles further on was Rakhni, which we reached as night was falling. Here we found a most exciting notice stating, "This road is patrolled between sunrise and sunset, except on Fridays and Mondays, and should not be used by travellers when not patrolled."

The next day's run was very similar to the last. It was drizzling all the time, and the mud, or rather slime, was getting worse. In many places, especially where the road was cut out of a hillside, even our knobbly tyres failed to grip, and we slithered about uncomfortably with a nasty drop on one side. We reached the end of the patrolled section and were glad to get a night's rest at Loralai. An excellent road took us on to Quetta, the car smothered in mud, and the crew enveloped in sweaters and greatcoats on account of the cold. Quetta we found still overcoming the effects of the earthquake. Reconstruction was in full swing, but there were still heaps of bricks lying about, and most of the houses in the affected quarter were temporary corrugated iron huts or brick walls with canvas tent-top roofs. The most important job here was to visit the Iranian Consul and obtain visas. Our first effort failed, as it was a Friday, the Mohammedan holiday; and the next two days, being Saturday

and Sunday, the Consulate closed down in deference to European custom! After kicking our heels over a very long week-end, we approached him on Monday and opened the conversation in outrageous French, having carefully rehearsed the opening phrases beforehand. The Consul, a most charming gentleman, winced visibly and switched off into very elementary English. Having discovered our wishes he gave us application forms to fill in. As we were Army officers we had to pay for a telegram to Teheran asking for instructions. Five days later the reply came permitting us to journey through the country but we were refused camera permits.

We had intended to travel *via* Kandahar, but the day before we started a Dutch commercial traveller arrived from that town and told us that he had just spent a fortnight attempting to get through by car from Kabul to Meshed, in Persia. After a frightful time with snow and floods he had come to a dead stop west of Kandahar, where a bridge had been washed away by the melting snows. As this route now seemed closed we decided to continue through Baluchistan, and make for Zahedan in Persia. A good metalled road took us a short distance before we passed the famous signpost "London—5877 miles." After this point the road deteriorated to rather a stony track and we saw nothing but bare rocky hills and very scanty vegetation for the next two hundred miles; speed had to be kept down to avoid damage negotiating the numerous dry nullahs across the road.

Most of the time we were close to the railway, reaching Dalbandin in the evening, where we spent a most comfortable night in the Rest House. We were interested to find there a British War Cemetery, dating back to the operations in 1916; Dalbandin must have been the railhead then. We stopped at Not Kundi, the Indian Customs Post, where merchandise is transferred from train to lorry for transit to Persia, and *vice versa*. Here our finance member set about buying some Persian money, sitting rather bashfully on a most beautiful carpet on the floor beside an old bearded Indian.

From Not Kundi onwards, the road became worse, and we just followed tracks where other cars and lorries had been. We picked what appeared to be the best tracks, and as often as not found better going by striking out on a new line. There was no sign of vegetation—just bare stony ground. For the last ten miles in Baluchistan, the road, such as it was, reached its zenith of frightfulness, and a steady 10 m.p.h. was all we could reasonably do. It was just dark when we reached Mirjawa, the Iranian Customs Post; as the officials all wanted to go to bed we got through fairly rapidly, though they sealed up our cameras with string and lead seal. We had hoped to stay in the Rest House, but as no one knew where the key was we had to push on in the dark to Zahedan. Here we were stopped by a policeman and the language difficulty became insuper-

able. We showed our passports but he did not understand them, and insisted on getting in the car and taking us somewhere ; we ended up at the British Consulate, so all was well. Though unexpected, we were given a wonderful supper and a bed, and we were delighted to find there the Dutchman who had left Quetta before us. In the morning we were given lots of slips of paper on which were written in Persian our names and passport numbers ; these we were to show to the police in lieu of our British passports, which they would never understand.

We set off north towards Meshed on a fair metalled road ; the country was wild and hilly and we passed an occasional heavy lorry. Once or twice we had to make a detour where the road was washed away by a stream, but our Waterloo was reached at a wide river. The water was two feet deep and flowing strongly ; the bottom was sound, and having tested it on foot first, we thought we could cross it. In we went, water piled up against the side of the car and stalled the engine, and the " Hanafiah " took on an ominous list. We were well and truly " shipwrecked," it was growing dark and every half-minute the car gave a little groan and slithered further downstream. It was practically impossible for us to stand still in the swiftly-flowing stream, as the current washed away the river bed from under our feet. We had the rope out and were pushing and pulling frantically, but every effort ended in a complete loss of balance and a ducking. At last, by engaging reverse gear and standing on the starting handle crank, we coaxed the car very slowly back towards dry land. We continued this laborious progress until the river bank became too steep, but fortunately the distributor was then safely above water. Then I had the ticklish job of taking it off, drying it with a pocket handkerchief from my suitcase, fearful of dropping anything, lest it rapidly disappeared downstream, and gingerly replacing it. Glory be ! After a few attempts with the starter, the engine fired with most fearful inward groanings, and I backed the car to dry land. The engine had boiled after five minutes' running, and investigation revealed a horrible frothy mixture of oil and water in the sump. Further running was unsafe, so with a vote of thanks to the fates for rescue from " perils from mountain torrent," we put on dry clothes (we saved our suitcases early in the proceedings) and soon had the Primus sizzling merrily away for supper, which was never more welcome. It was practically dark when a Persian lorry came along ; the crew took one look at the stream, then at us, put their greatcoats on, and dossed down for the night. We followed suit.

A depressingly cold and drizzling morning greeted us, but a breakfast of tea, corned beef and chocolate revived us. We bought a sumpful of oil from the lorry driver, gave the " Hanafiah " a " once over," and reconnoitred the river. There was a shallower crossing a hundred yards upstream, which we successfully negotiated.

The lorry, however, sank axle-deep at our last night's crossing, so we swapped the loan of our shovel for another sumpful of oil, as ours was still badly diluted with water. This day we travelled a further two hundred miles, passing through Shesb and Birjand. The roads were in a bad state, as a lot of melting snow had come down from the hills. The main street of Birjand was literally a river, and we splashed along on a narrow strip between the water and the houses. The road beyond this town was strewn with small boulders brought down by the mountain streams. There were large gangs of road-menders at work clearing the road and diverting streams, and often we had to wait while these men cleared a route for us. That night we slept again in the car, and the following morning, while testing another river-crossing for depth, two private cars came along, one containing the Dutchman and the other two Germans on a business trip. We therefore continued as an international convoy, giving each other a push or a tow-out as required. Many times at flooded places we had to test detours on foot, and progress was not rapid. Beyond Turbat Heidary we came to another impassable river, so we turned back and slept the night at an inn. We had a wonderful meal of fried goat, rice, cheese, chupatti, tea, wine and sour milk. The inn was a trifle primitive, but the beds were clean and, wonder of wonders, there was electric light in all the rooms.

We all reached Meshed the following day and stayed two nights in the Hotel Baghdad. It snowed most of the time and was very cold and wet; this worried us a bit, as the snow would only make the streams and rivers worse. The Hotel Baghdad was more or less European, the beds were clean and the food was good, but the organization broke down on sanitary arrangements and baths. We looked up "bath" in our Persian dictionary and showed it to the Major Domo. French is normally understood, but anyway our French was appalling and "*bain*," however mispronounced, never produced results. Our efforts with the dictionary were successful for we were shown the pride of the hotel—an enormous boiler, big enough to run a power station, with a complicated system of pipes terminating in a shower rose. The "genie of the bath" was summoned, who produced towels, soap, wood, coal, a mirror and a broken comb, and proceeded on the devilish work of lighting the fire. We stood around awe-struck and registered the appropriate amazement, partly real, when scalding hot water did at last emerge. After our ablutions we proceeded to the dining-room which differed very little from any normal European restaurant. We studied the menu, written of course in Persian, but the head waiter insisted on our having "bif-stek"; this we had, and excellent it was, as well as various other dishes—fair copies of French cooking.

We were treated to a cabaret while the meal was in progress. Two very pretty Persian girls in Paris dresses capered round rather

delightfully to the hotel orchestra, who tried to appear as American as possible, wearing "Tuxedos" and playing "Western" instruments. The music was undoubtedly Persian and had a strong monotonous rhythm, while the girls danced in low-heeled felt slippers. It was a most extraordinary mixture of East and West. After dinner we went to a cinema showing American films, "captions" in Persian being thrown on a separate screen, and local news reels entirely in Persian.

It took us a further three days to reach Teheran, stopping at Sabzawar and Damghan on the way. Two hours' run from Meshed brought us to a wide stream flooding over the road; crossing this our two offside wheels sank, and the poor old car sank down on her "tummy." A party of road-menders came along, diverted the stream and then, by jacking up and packing stones under the wheels, we managed to raise the car an inch at a time. At last, with everybody pulling, the wheels spinning and showering stones in every direction, the car shot out backwards like a bullet. For this service we rewarded the road-men with money and cigarettes. Their foreman, not to be outdone, presented us with a loaf of native bread, a long flat and flabby thing that could be rolled up and put in one's pocket. Incidentally, this bread was very light, and went down extremely well with our lunch.

We left Sabzawar in a snowstorm, and I think this was the coldest day's run we had; we had to stop and wipe frozen snow off our windscreen and halted at villages for the ubiquitous tea. The road was good (comparatively) though there were continued delays at rivers and floods. There was a fair amount of passenger buses and lorries on the road, and at one place a bus, stuck in a river, blocked all traffic for three hours. Owing to a difference of opinion between the bus driver and the other waiting lorry drivers a free fight started. An excited gentleman in a fur coat and pince-nez beseeched us in French to return to a village two miles back and fetch the *gendarmes*. As we certainly could not go forward I took him back and returned with five rather frightened *gendarmes*, with rifles and fixed bayonets pointing out of the sides of the car. On our return the contestants were too exhausted to continue, besides being terribly cold and covered with mud. A further argument ensued for another hour, and at last the bus was extricated by the simple process of towing it out with a lorry.. After that everyone insisted that we had first shot at fording the river, and threw in stones and brushwood to improve the crossing; four-gallon petrol tins, squashed flat by violently jumping on them, made excellent articles for the same purpose. With a grand splash we got through fairly easily, and continued on our way, though we encountered further difficulties with floods and mud later on. Most of our difficulties were due to the swiftly-flowing water piling up and swamping the engine, in spite

of the fact that we sealed up all we could with plasticine. Lorry drivers enveloped their engines in Persian carpets, which appeared wonderfully effective.

Teheran, the capital, was *en fête* for the Prince and his Egyptian Princess, who had left the day before. There were magnificent decorations in the streets in the Egyptian colour, green, and the Persian colours, green, white and red. The city is finely laid out with broad concrete roads and imposing buildings, and except for the Persian names on the shops there is little to distinguish it from any modern European city. We had some difficulty in finding rooms, but with the assistance of an official of the Anglo-Iranian Oil Company, we found accommodation in the Hungarian portion of the town. We were surprised to find German spoken, and plenty of delicatessen shops, sausages and beer. Most of the beer, incidentally, was a local or Russian brew, rejoicing in the name "Arbijau." Here we spent two nights, visited the British Consul, saw a film in French, bought some hand-engraved silver, drove round the town in a "gharry," and got permission to depart from the Chief of Police. The last we were told to do by the British Consul, who lent us one of his staff to help us. This written permission we were never asked to show, and Teheran was the one town we left without any formalities. Normally, passports were demanded at every town, on arrival and departure.

We travelled from Teheran to Kermanshah, 360 miles, in one day, and arrived late at night.

A pleasant run the following morning took us through the Pai-Tak Pass, an extremely steep and twisting road. Here we saw our first "wild" tortoise, waddling slowly across the road. He displayed surprising agility on our approach! By mid-day we reached the customs post at Kasu-I-Rui, where our baggage was searched to see that we were not taking out more money than we took in. Our cameras were unsealed, and after leaving the customs we took our only photos of Persia—pictures of the customs post! We were sorry to leave the country. The people were always hospitable and ready to help us, and after all, difficulty with passports had only been a matter of formality.

Our next stop was Khanaquin in Iraq, where we were delighted to find, at the railway rest house, a canteen with English cigarettes and tinned food. We had most welcome sausages and mash, and Dutch beer, and felt very pleased with ourselves. The road on to Baghdad was over a flat muddy plain, fortunately dry at the time, but there were bad wheel ruts to negotiate as well as large flocks of sheep and goats. We decided to "go a bust" in Baghdad, and put up at the best European hotel, paying more for two nights' lodging than for our eleven days in Persia. We walked round the town, obtained Syrian visas from the French Consulate and visited the

Nairn Transport Company about the desert crossing to Damascus. We found that we were supposed to pay £10 and hire a driver to take us across in a convoy. We explained that our car could not take an extra person, so it was agreed to let us start by ourselves. Nairns arranged for us the police inspection of the car, without which no car is allowed to cross; they also warned their manager at Rutbah Wells of our coming, and arranged for their relief car there to set us on the right road for Damascus.

The first day's "hop" to Rutbah was our first experience of real desert motoring. No road exists, but there are numerous tracks formed by continual use by desert transport. Most tracks lead to Rutbah, and by keeping a check on the sun and compass for direction we averaged 27 m.p.h. for the distance. Once or twice we were a bit worried at losing a track, but by passing now and then the five-kilometre posts we knew we were all right. These posts are, as far as I know, in a dead-straight line from Ramadi to Rutbah, but the tracks wander sometimes quite far from them. The surface was good, and high speeds were sometimes possible, always terminated by a hard application of brakes to avoid a nasty bump. For the crossing we bought Arab headdresses and a large supply of oranges. The headdress protects the eyes and mouth in a sand storm, which we never encountered, and made suitable subjects for photos entitled "Me in the desert." We had sufficient petrol in our tanks for the whole crossing to Damascus—560 miles; petrol at Rutbah costs 15s. a gallon—an expense we wished to avoid. There were various buses and Packard taxis crossing, and all had T.T. in large letters painted on their sides, which we found meant that they had permanent trans-desert police permits—T.T. standing for "Transport-Transdesertique."

Rutbah Wells, to give its full title, consists of a few Bedouin huts, two fresh-water wells which justify its name, a wireless station and a walled fort, containing a native police detachment, and the rest house. We had a most comfortable night here, and in the morning hired the Buick relief car to pilot us for the next fifteen miles; this was necessary, as various tracks from Amman and Northern Arabia converge at this point with the Baghdad–Damascus route, and are very confusing to the uninitiated. By mid-day we reached the Palmyra "switch"—the junction point of routes from Palmyra and Asia Minor. Two large stone pillars have been erected as a landmark which can be seen for miles, and help to guide trans-desert transport for large distances.

We reached Damascus in the evening and immediately visited the British Consul to inquire about conditions in Palestine. We were told to proceed *via* Beirut, Haifa and Jaffa to Jerusalem, as this was the only route kept open during the Arab troubles. Motoring was really pleasant now, a delightful metalled road wandered through

cultivated land, and the trees and grass appeared wonderfully green after our six weeks of dust, mud and stones. At the Palestine customs we were given military permits to proceed to Jerusalem. We travelled south through the Jewish colony, where men and girls were working all day in the fields. They all wore shorts and were tanned by the sun, and seemed to be an extremely healthy and contented community. At several places the road was barred by barbed wire and guarded by British troops and Palestine Police.

Leaving Jerusalem the following day, we had to go back towards Jaffa and then turn south along the coast road to Gaza, whence we intended to take the road to Beersheba. Unfortunately we missed the turning and got lost among a lot of camel tracks, but by asking the way from Arab shepherds, we eventually ended up at Beersheba all right. This, according to our A.A. route, was the customs post, but owing to the troubles the post had been moved back to Jerusalem. We found a few police here and learnt that it was quite safe to proceed to Suez, as there had been a bit of shooting the day before, but it was only at long range! Rather frightened, we turned south over a rocky track and reached Kosseima in the evening, where there was the Egyptian Customs Post, and a rest house, but we had to resort to our own food supply for supper and breakfast.

Next day we crossed the Canal by car ferry at Suez, and spent two nights in Cairo. At this time the international situation was not too good—Italy had just "walked" into Albania and things looked a bit grim. We decided, therefore, to travel straight through Lybia to Tunis, and then cross to Marseilles. The new desert road bore us north-west, and in two days' time we reached Mersah Matruh, and were right royally welcomed by the British troops. The road had again degenerated into a rough track, though a new road is being constructed, and after rather a bumpy journey we passed through the Egyptian wire at Sollum into a frightful rocky "no-man's land," with thick belts of barbed wire behind and in front of us. Ahead an Italian flag was flying from a handsome stone monolith; we passed this and barriers were raised to allow us to enter Lybia. Customs formalities were rapid, and we found ourselves on a good metalled road which took us to Tobruk. This is a naval and military station, and the civilian population is very small. We found, however, a very modern *albergo* ("road-house" is the best translation), built in white concrete; a cocktail bar, baths, hot and cold water in all bedrooms showed us that here was one of the latest efforts to develop tourist trade in Lybia.

The journey through this Italian colony took five days; the road was, magnificent throughout, though the scenery, except near Benghazi and Tripoli, was dull, sandy desert. Near towns and oases there were large numbers of small white concrete cottages, where the colonists lived; each one flew an Italian flag and had the

words " Ente Colonizzione del Lybia " painted on the wall. The colonists appeared to be scratching a very unattractive existence from the sand and in several places irrigation was being attempted by surface-laid pipes and sprinklers. The larger buildings had " Viva Il Re " or " Viva Il Duce " clearly painted on them, while every tower bore the words " Dux, Dux, Dux, Dux," etc., for the entire height. We soon learnt the value of the cheap, close-fitting, dark-blue goggles which kept both the flying sand and sun glare from the eyes, and wished we had taken the precaution of smearing our faces and bare arms with vaseline for protection against the same elements. The only other road-users were military lorries and trailers, and although we drove as fast as possible, we reckoned ourselves fortunate to see a colonist's cottage or palm tree every hour or so. The *albergo* was most welcome at the end of a day's run. Here there were always good food, iced drinks and clean beds, the furnishing was attractively modern, but it was pathetic to see how little it had been used by tourists, who were still extremely rare.

At Tripoli we saw the Maserati, Alfette and Mercedes teams practising for the Grand Prix. The cars did as much practice in the main streets of the town as on the course itself, and people stood back and cheered as an Italian Maserati snaked through the traffic at over 100 m.p.h. Above the roar of racing cars rose the strains of martial music and we watched the changing of the guard at the local *castello*. We got badly caught out when the crowd, who evidently knew the drill, raised their arms in the Fascist salute. As we had failed to comply, there were nasty murmurings near us, so we watched carefully and soon were saluting away merrily with the rest.

We left Tripoli early in the morning and enjoyed a glorious run through palm groves by the sea to the Tunis frontier. The country became more green and fertile as we travelled west, and in Tunisia the roads were flanked with olive orchards, a pleasant sight indeed after rather a monotonous drive across Lybia. We spent a night at Sfax, an old French seaport, where the harbour was full of fishing smacks and a few naval ships. In the evening we drank Vermouth at one of the numerous cafés and watched the cosmopolitan population drift by on their evening *promenade*.

In Tunisia all but the extremely menial tasks were carried out by Europeans, and our hotel at Sfax had the inevitable *madame* in charge. We were overjoyed to get here delicately-cooked French meals, especially after eight weeks of our own pot-luck and indifferent cooking. Tunis we found a very lively town, with music and cabarets in the cafés ; we never had a dull moment. Our treasurer cashed the last remaining traveller's cheques and booked passages on the *President-del-Piaz*, sailing for Marseilles the following night. There was no difficulty about the customs here, as the shipping company

1.—Loading at Singapore.

2.—Picking up petrol in Loralai.

3.—Quetta Reconstruction.

4.—Between Nushki and Dalbandeh in Baluchistan.

The cruise of the 'Hanafiah' 1 - 4

5.—Persian Customs, Iran, Iraq frontier.

6.—In the desert between Baghdad and Damascus. (One of the 3 kilometre posts.)

7.—Buying Oranges in Jerusalem.

8.—Filling up at Sirte (Lybia).

The cruise of the 'Hanafiah' 5 -8

carried out all necessary formalities with regard to our *carnet* and loading the car. The ship sailed at midnight and in the morning was at Bizerta picking up further passengers. The crossing took thirty hours in rather a rough sea, and though the recorder struggled valiantly with his rather neglected diary, we found that eight weeks on the road had not improved our seafaring abilities. True to their word, the company had our *carnet* arranged before we landed, and we drove the car away immediately it was unloaded.

The last stage of our travels took us up the Rhone valley through Troyes and Soissons to Calais, a very happy drive through the cheerful green of the French countryside and myriads of brightly-coloured petrol pumps. The *Autocarrier* bore us across the Channel, and our grand tour ended with a large meal, Bass on draught, and a visit to the Palladium in London.

The "Hanafiah" was not of great value as a touring car in England, with all her modifications. She was "traded in" like any other car, but to us three her name will always recall our days in Singapore, the heat-scorched Grand Trunk Road through India, streams rushing across the road in Persia, our first view of the sea at Beirut, the endless road across Lybia, and our first pint of "bitter" in good old London Town.

CENTENARY OF RAILWAY INSPECTION.

COMPILED BY THE EDITOR, "R.E. JOURNAL."

A BROCHURE (price 1s.), reprinted from the *Railway Gazette* of 12th July, 1940, records and discusses the work of the Inspecting Officers of Railways, whose appointment was authorised by an Act of Parliament one hundred years ago. Their duties were to examine new railways and to report on construction and equipment, while the companies were required to notify all accidents involving personal injury. At the present time, besides exercising the Minister's relative functions, powers and duties regarding the inspection and safety of railways, tramways and trolley bus routes, the inspectorate is concerned with the maintenance of these undertakings; also with their technical operation and efficiency, their protection, and the adequacy of staff, equipment, supplies, and power, including such matters as the provision of ambulances and casualty evacuation trains.

The Inspecting Officers have always been drawn from the Corps of Royal Engineers, and it is of interest to the Corps to reproduce the list of these officers as published on page 16 of the brochure.

BOARD OF TRADE.

*Lieut.-Colonel Sir J. M. Frederick Smith ...	1840–1841
Lieut.-Colonel R. Thomson	1840
Captain S. C. Melhuish	1840
*Major-General Sir C. W. Pasley	1842–1846
Captain J. Coddington	1844–1847
General Sir J. Lintorn A. Simmons	1847–1862
Lieut.-Colonel Geo. Wynne	1847–1858
Captain R. M. Laffan	1847–1852
Captain D. Galton	1850–1857
Captain H. W. Tyler	1853–1876
Colonel W. Yolland	1856–1884
Captain G. Ross	1858–1861
Colonel F. H. Rich	1861–1891
Major-General C. S. Hutchinson	1867–1895
Colonel Sir Francis Marindin	1877–1899
*Lieut.-Colonel Sir H. Arthur Yorke	1891–1913
Lieut.-Colonel G. W. Addison	1894–1899
*Lieut.-Colonel P. G. Von Donop	1899–1916
†Colonel Sir John W. Pringle	1900–1929
Lieut.-Colonel E. Druitt	1900–1918
Lieut.-Colonel G. L. Hall	1919–1927

MINISTRY OF TRANSPORT.

†Lieut.-Colonel A. H. L. Mount	1920
Colonel A. H. C. Trench	1927
Lieut.-Colonel E. P. Anderson	1929–1934
Lieut.-Colonel E. Woodhouse	1930
Major G. R. S. Wilson	1935

* Inspector-General of Railways.
† Chief Inspector Officer of Railways.

Commenting on the choice of Royal Engineer officers for these duties, the brochure adds :—

" The choice of Royal Engineer officers, invariably made throughout the whole period, for the important duties involved, has been motived by the wish to secure a wide engineering knowledge, combined with broad general judgment and entire freedom from bias with regard to railway managements, to their employees, or to any interfering interest, so as to secure impartial treatment of the frequently grave issues involved in assessing the full consequences of an accident, or other matter calling for an expression of opinion and the tendering of advice to a Department of the Crown. The results attained and the high standard of safety so happily enjoyed by British railways show that the choice has been more than justified. In 1907 the late Sir Arthur Yorke said that ' the relations between the Inspecting Officers and the railway companies are of a friendly nature and the latter do all they can to assist the former in the performance of their duties.' Those relations have remained no less cordial in the years since the above words were spoken ; the railway trade unions, too, have come to place full confidence in the Inspecting Officers and to recognize that railwaymen receive scrupulous consideration in the course of the often difficult investigations rendered necessary by an accident."

MEMOIRS.

LIEUT.-GENERAL ERNEST KER SQUIRES, C.B., D.S.O., M.C.

Colonel Commandant (Designate) Royal Engineers.

ERNEST KER SQUIRES was the eldest son of the Rev. R. A. Squires, formerly Vicar of St. Peter's at St. Albans, and was born at Poona on December 18th, 1882. He was educated at Eton, where he was a King's Scholar and where the Rev. L. G. B. J. Ford was his tutor. He passed into the Royal Military Academy at the end of 1900. Here he was an Under-Officer, and passed out high up in Satterthwaite's batch, receiving his commission in the Corps on January 17th, 1903.

After two years at the S.M.E. he went to India early in 1905, and joined the Third Sappers and Miners at Kirkee as company officer of the 22nd Field Company. Here he remained until 1908. At that time it was almost impossible for a Third Sapper subaltern not to play polo and to row, and Squires did both ; his great weight was a handicap at polo, but he was a really fine oar and was a powerful member of the R.E. crew, which, stroked by his captain, G. H. Boileau, remained unbeaten for many years. In 1908, his company was transferred to Quetta, and shortly afterwards, on Boileau going to a staff appointment, he took command of it. At that time the Quetta Infantry Brigade was commanded by Major-General Fenton Aylmer, V.C., and Squires, in addition to his work as company commander, acted as Orderly Officer to the General. He also found time to run the local amateur dramatic society, and some of his friends may remember the shock received by the very celibate mess at Kirkee when a photograph appeared in an illustrated paper of Ernest Squires posing happily in the centre of at least thirty fair damsels.

Squires left the 22nd Company in 1910, when he was given the command of the 23rd Fortress Company at Aden. His five years with the 22nd Company had been a period uneventful in itself but filled with hard work ; and we may well claim for him a share of the credit for the brilliant work which this company did in Mesopotamia later.

He remained at Aden until June, 1913, when he returned to Kirkee. In 1912 he had married Sylvia, the daughter of the late Sir H. Risley, K.C.I.E., C.S.I., and step-daughter of General Aylmer.

Lt-Gen Ernest Ker Squires CB DSO MC

On promotion, as no field company was vacant in the Third Sappers, he left them and became Garrison Engineer, Poona. In August, 1914, he was sent to Bombay to help two of the Third Sapper companies to fit out ships as transports.

A few weeks later he sailed for France as Asst. Field Engineer in the Lahore Division, in which the 20th and 21st Field Companies, Third Sappers and Miners, were serving. These companies were put in as infantry in the attack on Neuve Chappelle on the 29th October, 1914, and lost all their British officers and half their strength in capturing the village, which they held until ordered to withdraw. Consequently, in November, Squires joined the 21st Company, now under the command of Captain B. C. Battye. A few weeks later, however, he was wounded during the action at Givenchy and invalided to England. He returned to France and to the Company in April. The Lahore Division was rushed up to Ypres, when the first gas attack took place. Battye was wounded about April 22nd, and Squires took command, but was himself again wounded three days later. He was again invalided to England and did not come out again until August, this time as Field Engineer in the Division. For his services at " Second Ypres " he was awarded the M.C.

Squires sailed with the Lahore Division from France to Mesopotamia in December, 1915, and on arrival there was appointed Staff Officer to the Chief Engineer, Tigris Corps. In this capacity he served through all the bitter fighting of the attempt to relieve Kut in early 1916, and in the recapture of Kut and the advance to Baghdad a year later. In 1917 he took command of the Field Squadron with the Indian Cavalry Division. He was promoted Major in January, 1918, and in June the same year he left Mesopotamia to become Instructor at the Cavalry School at Saugor. During the war he had been five times mentioned in despatches, and he was awarded the D.S.O. in 1916.

On the outbreak of the Afghan War in May, 1919, Squires was given command of the 73rd Field Company, Third Sappers and Miners, on the Baluchistan front. The operations here were not very eventful, but he took part in the only action of importance, the capture of Spin Baldak Fort. His Chief Engineer described him as a Tower of Strength, and he was again mentioned in despatches.

In January, 1920, he was nominated to the Staff College at Quetta. This ended his active connection with the Third Sappers and Miners, but he always considered himself a Bombay Sapper, and, whenever he was in England, his large and genial presence was always a welcome feature at their table at the Corps Dinner.

Squires graduated from the Staff College at the end of 1921, and there commenced for him a long series of Staff appointments. He was G.S.O.2 in the Directorate of Military Operations at Simla from 1922 to January, 1925, when he came home to serve as G.S.O.2

under the Director of Staff Duties at the War Office. During his three years here his ability began to be recognized and he spent 1928 as a student at the Imperial Defence College. He was promoted Lieutenant-Colonel in January, 1929, getting his Brevet Colonelcy at the same time. He was then temporarily attached to the Chief Engineer, Eastern Command, until in December he was appointed an Instructor at the Staff College. He left Camberley in October, 1932, to become Brigadier, G.S., Southern Command. Here, as always, he had an unqualified success. An officer who served on the Southern Command Staff with him writes: "I doubt if there was ever a better Chief of Staff in any Command. He worked long hours, but was never too busy to see and hear anyone who wished to consult him. He always willingly heard both sides of any question, and, if he had to give a decision against one, it was done so nicely that no one ever minded." Another says: "His thoroughness and ability to grasp every aspect of all the questions that came up to him were extraordinary."

In December, 1935, Squires was promoted Major-General and next April he became Director of Staff Duties at the War Office. Here he was faced with a heavy task, as a result of the Government mandate, given early in 1936, for reorganizing and rearming the Army. Finance was the ruling factor, as the Government hoped to carry out rearmament as cheaply as possible, and were only driven, stage by patient stage, to successively larger estimates.

At the outset, estimates of the programme were called for from each of the three Services. For those not concerned it will be difficult to appreciate what an immense amount of work this involved. A rearmament budget and programme had to be prepared, based on organizations and forms of equipment not yet in existence. These had first to be organized on paper, without experience of the practical use of the new formations, and then the estimates of cost had to be prepared.

Then the estimates were cut down severely and plans had to be adapted, involving an enormous amount of work. At the same time, the actual reorganization had to be put in hand. Here again the task was enormously complicated, due to the Cardwell system. Apart from the reorganization of the home forces, units abroad had to be maintained in some state of readiness, and the programme of reliefs fitted in to allow for the reorganization and modernization at home.

On the equipment side, new types of equipment had to be designed and tested, and demands for production submitted.

All the time German power was growing and our own commitments increasing with the successive Italian crises in the Mediterranean and the growth of unrest in Palestine. Inevitably the cost of the programme began to rise. The Government, however, called for

yet more revised estimates of the total programme, and each time an immense amount of work was involved in calculating our liabilities and the cost.

From all this some faint idea may be gained of the burden of work which fell mainly on the Director of Staff Duties. Nevertheless Squires never seemed upset or tired and, at times of greatest stress, showed a particularly attractive sort of spontaneous cheerfulness. His staff all admired and liked him, not least for his calmness and consideration for those under him during these difficult years; and, although they were pleased when further advancement came to him, the news was received with an unpleasant shock and sense of loss. It must always be remembered that many of the things in the equipment and organization of the Army which the recent fighting has proved good were due to Squires' foresight.

In June, 1938, Squires was selected by the Australian Government from a panel submitted by the British Government for the appointment of Inspector-General of the Australian Military Forces, with the rank of Lieutenant-General.

On arrival in Australia in July, he found himself faced with problems somewhat akin to those with which he had dealt at the War Office. The Army of the Commonwealth, which had been so formidable in 1918, had, like the British Army, lapsed into a small force, whose numbers, training and equipment were quite incompatible with the new dangers which now loomed ahead; and which was maintained somewhat grudgingly by successive Governments, who expected a long era of peace and who had many other calls on their resources. It was the duty of General Squires to make recommendations as to how this situation was to be met—no easy task for a man new to Australia and faced with all the natural prejudices of a great Dominion against "outside" influence. But his transparent honesty and the fact that no one could suspect him of anything underhand or of any backdoor methods made him the man for the job. No one could have been accepted more completely or more wholeheartedly by the soldiers of Australia. The decisions on his recommendation lay, of course, with the Australian Government; but many of them were eventually accepted—including the principle of a small standing army, the doubling of the strength of the Militia and the grouping of the divisions and districts into four Commands; and though they only began to take concrete form from the time that the present war started, they have already proved themselves of immense value.

In September, 1939, General Squires was appointed Chief of the General Staff of the Australian Army, and as such he had much to do with the dispatch of the Second Australian Imperial Force to England. And he continued to work for what he believed Australia required—more men, better trained men and better equipment.

But his health failed ; early in 1940 he became seriously ill, and later had an operation. He died on March 2nd at the age of 57.

His death must be regarded as a grievous loss to the Corps (in which he had been appointed Colonel Commandant in January, 1940) and to the British and Australian Armies. The Australians had come to a very high appreciation of his character and work, and their admiration was exemplified by tributes from the Prime Minister and many prominent men in the Commonwealth, including some who had earlier opposed his proposals. And Mrs. Squires received many hundreds of letters of sympathy from all classes and sections. We may quote two of these. The Minister of Defence, Brigadier Street, who had been intimately associated with him in his work, wrote : " His death is a tragic loss, not only to Australia, but to the whole British Commonwealth of Nations. He arrived at a very critical period of Australia's history, and Australia has undoubtedly a great deal for which to thank him for his planning both before and after the outbreak of war. His memorial is Australia's preparedness for war." And his successor as C.G.S. (General Sir Brudenell White) ended a letter to Mrs. Squires with the words : " it must, however, be some consolation to you to know that your husband has left us a record of service and nobility of character which will be both a lasting memorial to his name, and an inspiration to those who follow after."*

The Commonwealth Government also showed their appreciation by a great military funeral, in which the leading detachment of the escort was appropriately drawn from the Royal Australian Engineers.

The sympathy of the Corps will go out to Mrs. Squires, who shared with him the affection of a wide circle of friends, and to his children. He leaves two daughters—one married to G. Essame, now serving in the R.A. (Anti-Aircraft), and the second to W. S. A. Landale, now serving in 2nd A.I.F.—and a son, now at Eton.

Ernest Squires was a very tall man, and his height was matched by great strength and soldierly bearing. He was always cheery and imperturbable, and always good company. He was universally loved, but the memory which will endure strongest among his many friends is that of his absolute sincerity. It was simply impossible to associate him with anything mean in thought, word or deed. He was the personification of honesty and kindliness. And this memoir may well end by applying to him the lines of Kipling's memorial verses to his own brother-in-law :

" E'en as he trod that day to God, so walked he from his birth,
In simpleness and gentleness and honour and clean mirth."

E.V.B.

* Sir Brudenell White and Brigadier Street, with two other Commonwealth Ministers, were killed in an aeroplane accident near Canberra on August 11th ; a tragic loss to Australia at this juncture.

Col Harald George Swayne CMG

COLONEL HARALD GEORGE CARLOS SWAYNE, C.M.G.

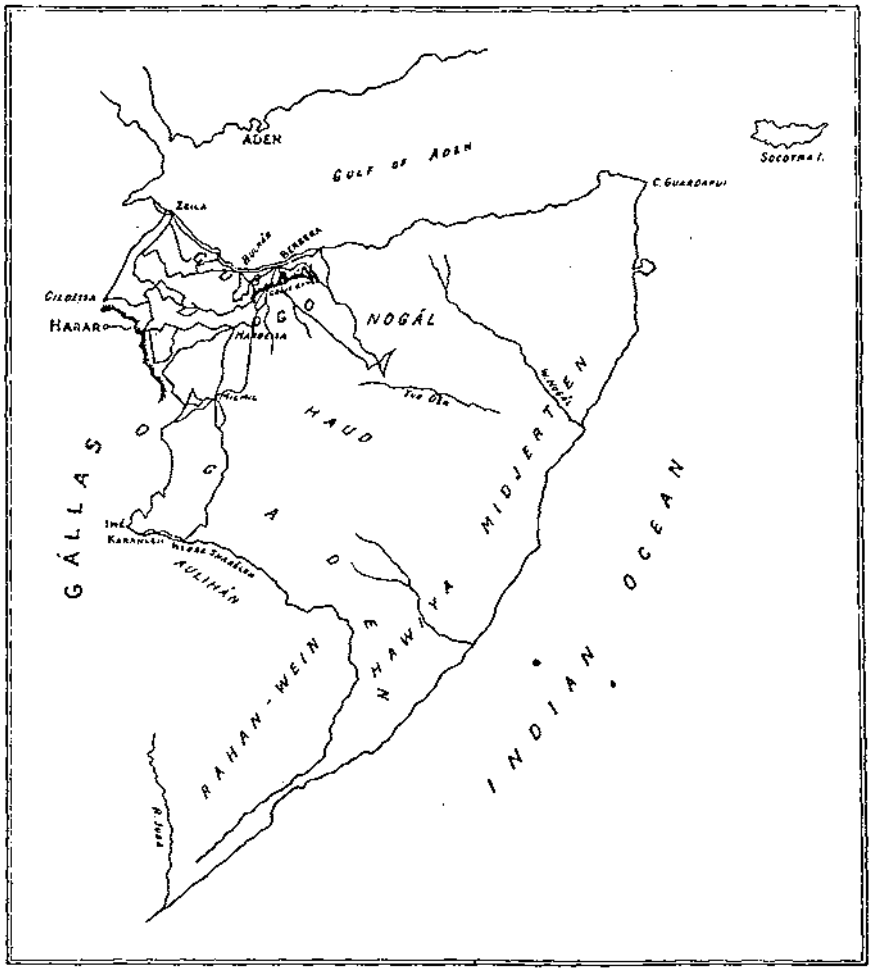
THE name of the subject of this memoir is probably almost unknown to the present generation of Royal Engineer officers, but two generations ago he obtained a well-earned recognition, not only as a sportsman and shooter of big game but as an intrepid and painstaking explorer of the north-east corner of Africa, now known as Somaliland.

Swayne liked to be referred to as the last of the early explorers, in succession to such great names as Burton, Livingstone or Stanley. When he went to the Somali coast in 1884 the hinterland was unknown to Europeans; when he left it for the last time in 1897 the country had been reconnoitred, boundaries fixed and contact established with Abyssinia and with the French and Italian settlements. Further, in the course of journeys covering many thousands of miles of route, he had obtained a personal knowledge of the people occupying the country, and of the physical geography and the fauna and flora, much of which was new to science. He became in time a life Fellow of the Royal Geographical Society and was also a Fellow of the Royal Zoological Society. In 1894 he published a book of his experience under the title of *Seventeen Trips Through Somaliland*, written mainly from the point of view of sport, but containing much detail of the people and the country. When Somaliland came into the limelight by the operations against the Mad Mullah in 1900 to 1903, this book became a standard work of reference and new editions were called for in 1898 and 1903.

In all his trips into the interior, whether official or private, Swayne made a reconnaissance of his route and notes on the people and places, and on his return made reports through the Indian Government to the Indian and Foreign Offices. During all the discussions on Somaliland he was consulted by these Offices and in 1903 Lord Curzon stated in the House of Lords that Major H. Swayne was the leading authority on Somaliland.

Harald George Carlos Swayne was born in 1860, he was the eldest son of the Reverend G. C. Swayne, a Fellow of Corpus Christi, Oxford, who was for many years an Anglican Chaplain in France, Italy, Germany and Switzerland. Swayne was educated at Manilla Hall, Clifton, and in 1878 joined the Royal Military Academy, passing out as Lieutenant, R.E., in February, 1880. Electing for service in India, he joined the Bombay Sappers and Miners and in 1884 was ordered to Aden with a company of that Corps. Up to 1884, the coast of Somaliland on the south side of the Gulf of Aden had been

controlled by Egypt, who had also a garrison at Harar, but in 1884 all Egyptian garrisons were withdrawn, and an Arab Emir took control at Harar. Aden was interested, as about half the native inhabitants of this town are Somalis and many supplies for the town



are drawn from Somaliland, including about 60,000 sheep each year. The Indian Government therefore appointed Residents in Somaliland and sent small detachments of troops and police to occupy the coast ports of Berbera, Bulhar and Zeyla. In 1885, Swayne with a detachment of Indian Sappers was sent to Bulhar to build police barracks and defences against attacks by the local tribes. These latter were often raiding one another, and although they had no special enmity against the British and indeed looked to us for protection, they resented the attempts of the Residents to stop the inter-tribal

warfare. On one occasion Swayne, as the senior military officer, had to lead a charge at the head of twenty-five mounted men of the Aden troop and some police, but these local troubles did not become serious. The country abounded in game of all sorts, while big game, including elephants, lions, rhinoceros and hippopotamus, could be found in many localities. Officers from Aden began to come over on shooting trips and an article by Swayne published in *The Field* attracted the attention of sportsmen of all nations. In August, 1885, Swayne, who had been spending his leisure in making reconnaissance sketches of the country round Bulhar, was instructed by the Indian Government to make a reconnaissance of the coast and hinterland. Between this date and February, 1887, he was employed on this duty. At first he had an escort of Indian cavalry, but finding this caused local unrest, he replaced them by an escort of Somalis about thirty in number, whom he armed and trained not only for protection but to assist in the survey work. In this, his first survey, he covered 2,000 miles of route and made many expeditions into the interior, getting in touch with the tribes with whom he soon established friendly relations. In nearly every case he was the first European who had been seen by the inhabitants. He learnt to speak Somali and used it as easily as he spoke English, and developed a great friendship with many of his followers which they reciprocated. In 1887 he returned to India, where his routes, which had been checked by many observations for latitude and longitude, were compiled under his supervision as D.A.Q.M.G. in the Intelligence Office at Simla, and the resulting map was printed at the Bombay office of the Indian Survey. Full reports were also sent to England and in these Swayne is credited with having introduced the term " sphere of influence " to cover our interests in Somaliland, a term which has since taken a definite place in our Colonial history.

In 1888, Swayne, whose reputation had by this time reached England, was engaged by the Imperial British East Africa Company to lead an expedition to Mombasa to develop that port and to organize an expedition to the Albert Nyanza to look for Stanley, who had disappeared into the interior of the Congo region in an attempt to relieve Emin Pasha. The expedition was to endeavour to drive cattle with them into the interior and for this purpose Swayne secured the services of some of his Somali subordinates. Swayne was given the acting rank of Captain and had a substantial party under his command, which was to include twelve Europeans with 900 armed Swahili porters and two Maxim guns. His second-in-command was Mr. Jackson, well known later for his work in Uganda. Just as the party was leaving London, news was received *via* the West Coast of the death of Major Bartellot with Stanley's rearguard, and when the party arrived at Mombasa it received the news that Stanley and Emin with a large party had arrived at a

port in German East Africa. Swayne's expedition was thus cancelled but he was under engagement for six months with the British company and was employed in carrying out exploration and survey work on the River Tana. This ended in rather a spectacular manner, when Swayne, alone at midnight in a dugout canoe, and pursued by an irate hippopotamus, was rescued just in time by the presence at a bend of the river of H.M. survey vessel *Stork*, commanded by Captain Pullen, R.N.

At the end of his six months' engagement Swayne, who had contracted fever, did not renew his engagement but returned to India. Promoted Captain in July, 1889, he took part in the Chin-Lushai campaign in Burma, being employed on roadmaking in a hostile country with Indian Sappers. For this he received the medal and clasp. On returning to India the Indian Government asked him to undertake a survey of the whole of Somaliland on the same lines as his previous reports, and offered him the services of an officer of the Indian Marine to assist in the technical work. Swayne was confident of his ability to carry out the survey himself, he had been through a very full survey course at the S.M.E., Chatham, under Major Sir Charles Warren, and Captain W. G. Morris, R.E., and had also, on the introduction of the Royal Geographical Society, taken a series of lessons on navigation from a retired Naval officer, Captain Coles, R.N. He therefore asked that instead of the officer suggested by the Government he should have the assistance of his own brother, Lieut. Eric J. E. Swayne, of the 16th Bengal Infantry. This was approved and during 1891 and 1892 the two brothers carried out a series of route marches at slow camel pace, which covered over 7,000 miles. The methods previously adopted by Swayne were continued and developed, a route by prismatic compass on a stand was recorded each day and this was checked by many thousand cross-bearings, using a large 8-in. transit theodolite, and by observations of the stars by a large telescope, which fixed the latitude and longitude with a considerable degree of accuracy.

In the course of their wanderings, the brothers, while not delaying the survey work, took every opportunity of sport. The country was then infested by lions, and on one occasion Harald Swayne was attacked by a lioness which seized and mauled his right shoulder. His life was saved by his brother Eric, who running in to close quarters shot the enraged animal. Swayne was severely injured but carried on the survey until he had to go down to the coast to have his arm dressed by a native hospital attendant.

The last expedition carried out by the brothers was into the highlands surrounding Harar on the border of Abyssinia. This town, which is the centre of a flourishing area, had been left in charge of a local Emir when the Egyptian garrison was withdrawn in 1884, but in 1887 the Abyssinians under Ras Mackunan, a son of King

Menelik, occupied Harar, and started marauding expeditions against the neighbouring Somali tribes. These latter appealed to the British Government, whom they had come to regard as their Suzerain and Protector, so Swayne was asked while carrying out the survey to report on the general situation. His route took him to Gildessa, a small town in Abyssinian occupation, about 20 miles north of Harar, where he and his brother entered the town with some attendants and were soon in conversation with some of the mixed crowd in the market, which included Arabs, Gallas and Somalis. Meanwhile the Abyssinian officer in command of the town stopped Swayne's caravan and diverted it into a central enclosure used as a barrack by the small garrison. As Swayne wrote in his book, it would never do to admit that an English party could be dictated to by any local official whether Somali or Abyssinian, so Swayne at once demanded an interview with the officer in command, while his brother took charge of the convoy, formed it in column of route and detailed advance and rear guards. The local garrison of about equal strength turned out under arms and for a short time an affray seemed imminent, but the firmness and tact shown by Swayne prevailed, and he was allowed to march out to a camp outside the town, where he agreed to wait for 48 hours while a report was sent to the Abyssinian headquarters at Harar and instructions were received from Ras Mackunan. At the end of 48 hours no reply had been received so Swayne, in spite of protests, started on his march to the coast at Zeyla. He was followed by a messenger from the Ras with a cordial invitation that Swayne, as the first Englishman who had visited the area, should come to Harar. This Swayne was unable to do, but he sent a polite reply promising to make a visit at a later date. This expedition, which included a survey of the proposed boundary between British and French Somaliland and Abyssinia, was the last trip made by the brothers and on the receipt of their reports in India they received letters of thanks from the Commander-in-Chief in India and from the Government of Bombay, with a personal note from the Governor, Lord Harris, to Harald Swayne, congratulating him on continuing at work after being attacked and mauled by a lion.

The survey carried out by the brothers was completed on the return of Swayne to India, a skeleton of the points fixed by astronomical observations being prepared and the detailed routes being fitted to this skeleton. The final maps were photozincographed at Calcutta at the headquarters of the Survey of India, then under Sir Thomas Holdich. Although not based on a rigorous triangulation, Swayne's survey was sufficiently accurate for all practical purposes. His maps were at first marked confidential, but when the official ban was removed they became the basis of all maps of the region both at home and on the continent. The total area covered was

about equal in area to the whole of England and Wales. Swayne's reports of his various reconnaissances were published by the Government of India in two blue books; these included not only a detail of the work done but an historical summary of the growth of Somaliland from the earliest times, a detail of the many different tribes, each tracing descent from an Arab sheik, and valuable notes of a political nature on the fighting qualities of the tribes and their relations with their French, Italian and Abyssinian neighbours.

In 1893 Swayne became due for long leave out of India and spent this on a project which he had had under consideration for some time, to lead an expedition for exploration and sport from Berbera across Somaliland to the head waters of the River Shebeyli and to attempt to reach Lake Rudolph, which had recently been discovered by an Austrian expedition. He obtained leave for this, though the political department was unable to make the trip official or to give him any direct assistance, but Swayne had just received a legacy of £600 which he spent on the expedition in the purchase of stores, arms and camels. He organized with this what he described as the best-equipped party he had had under him. It comprised 24 men picked from 200 applicants and these he armed with Snider carbines, for which he took 150 rounds apiece. He used 50 of these for preliminary training and taught his little force a simple form of drill and tactics, adapted to the conditions he had to meet. It may be noted here that Swayne never used his little army to force his way into any area against the wish of the inhabitants. His armed escort was necessary to prevent attacks by marauders and on two occasions when he was approaching Harar he had to make a display of force to resist a threat by the Abyssinian armies. But his combination of firmness and tact always enabled him to carry out his plans without fighting and in his case it may be truly said that Preparing was Preventing.

He was the only European with the party on this trip, but his head man and his two hunters were trusted friends on whose loyalty he could rely. In selecting the route he decided to commence by visiting Harar in reply to the invitation of the Ras. Space does not admit of much detail of his experiences on this trip, in the course of which he reached the Webbe Shebeyli or Leopard River, at a distance of 400 miles from Berbera and about the same distance from the east coast of Africa. At Harar he was greeted most cordially by Ras Mackunan and on leaving received from him a gift of a grey riding mule with embroidered equipment, a buffalo hide officer's shield, two spears and other presents. This gift caused great interest at the various places he reached on his march. Time did not admit of Swayne reaching Lake Rudolph but he reached his main objective, the Webbe Shebeyli, at a place called Imé and followed the river eastward for about 70 miles, when he turned north again by a route

which took him across a waterless tract of the Haud, the high inland plateau 4,000 to 6,000 feet above the sea, which extends along the south of Somaliland proper. In the four and a half months he took over his trip, he had covered one thousand two hundred miles of route. At many points on the route he was the first European who had been seen by the natives, and when he told them he was English, he heard many complaints of raiding by the Abyssinians and also collected much information of a political nature. At Imé, where he was treated as the guest of honour, the population thronged round him on his departure, beseeching him to ask the Great Queen to arm their country and stop the Abyssinian raids! This was duly reported to the British Foreign Office together with much other political detail and Swayne received a letter of thanks for the report.

On the completion of his four and a half months of exploration he returned to Aden, only to find that an extension of leave he had applied for had been granted, so he at once returned to Berbera and organized a second party of 34 men. With these he again crossed the Haud to the Webbe Shebeyli, with the intention of crossing that river and exploring Gallaland down to the River Juba. With the help of a flying raft he got his whole party safely across the river, but found that the tribes in Gallaland had been much upset by an exploring party from the East Coast of Africa under a foreign explorer, who had forced their way through the tribes. Swayne managed after some delay to make friends with the tribes bordering the river, but the approach of the wet season compelled him to cross to the north bank and he returned to Berbera by another route across Somaliland. In both these expeditions Swayne kept a record of direction and distances, but made no astronomical observations. He made a careful study of all the animal life, finding many types which were almost unknown, and identifying seven new types of antelope of which two were named after him. These were the Somali Hartebeest (*Bubalis Swaynei*) and one of the little Dik-dik antelopes (*Madoqua Swaynei*). Later, when Africa House was opened in Trafalgar Square, he gave one of his rhinoceros heads for the decoration of the office of the East African dependencies. On completion of his leave he joined at the S.M.E., Chatham, where he commanded a company and in 1894 was called to the Foreign Office as a witness before the Anglo-Italian Boundary Commission, receiving again a letter of thanks for his services. At the end of 1895 he returned to India.

But his close connection with Somaliland affairs was not yet finished. During the years following his visit to Ras Mackunan at Harar in 1893 the development of Abyssinia had progressed very quickly and this country had come into the turmoil of world politics by King Menelik's defeat of an Italian force at the battle of Adowa

in January, 1896. The raids of the Abyssinians into Somaliland had increased the unrest in that country, while the French at Jibuti were jealous of British expansion. The British Government therefore decided to send a political mission to King Menelik at Addis Ababa with a personal message and presents from Queen Victoria to the King. The mission was also to endeavour to arrange a settlement of the relative boundaries of Abyssinia and the French and British spheres of influence. The head of the mission was Mr. Rennell Rodd, C.M.G., then chief Secretary of the British Agency at Cairo, and the second-in-command was Lieut.-Colonel F. R. Wingate, C.B., then Director of Military Intelligence with the Egyptian Army ; the other military members were Captain Harald Swayne, who represented the Indian Government and was given the temporary rank of Major, also Captain the Hon. Cecil Bingham, 1st Life Guards, with Captain Lord Edward Gleichen and Lieut. Lord Edward Cecil of the Grenadier Guards. The civilian members of the mission were H. H. Pinching Bey, second-in-command of the Egyptian Sanitary Department, who was in medical charge, and Captain Tristram Speedy, a well-known traveller and big game sportsman, who had been attached to the expedition to Magdala in 1867 and was selected for his knowledge of the country and of the Amharic language. The mission had an escort of 20 Sowars of the Aden troop, armed with carbines and lances, under a Jemadar and of a Havildar and eleven members of the Somali police who were dressed in khaki uniform and armed for the occasion. All the members of the mission carried their full-dress uniform, and Gleichen, who wrote an account of the mission under the title of *A Mission to Menelik*, noted that except Mr. Rodd and Gleichen himself all the members exceeded 6 feet in height, the average of the whole being 6 feet 1 inch ! They were thus well able to impress the natives both socially and physically.

Swayne was entrusted with the selection and purchase of the presents for the Emperor and his family and was also responsible for the provision and management of the transport. To help with this he obtained the services of some of his Somali followers, under the headman who had accompanied him in all his previous journeys. This was no light charge, the expedition started with 185 camels, which had to be changed at Gildessa for local donkeys and again changed at Harar for mules, of which 300 were required. These mules had all to be purchased, according to the custom of the country and were sold again on return to Harar, when a spirited auction resulted in an unexpected profit !

Largely owing to the efficiency of Swayne's arrangements, the mission marched from the little port of Zeyla to Addis Ababa and back, a distance of 960 miles in all, between the 20th March and the 14th June, 1897. Swayne, in the second edition of his book, *Seventeen Trips Through Somaliland*, gives many interesting details,

but the only incident of note was that soon after leaving Zeyla the mission encountered several parties of Italian prisoners, 2,000 in all, who had been captured at the battle of Adowa and were being repatriated. The reception of the mission was most cordial and on its departure it was escorted from the capital by an Abyssinian army of 20,000 men dressed in striking uniforms; the officers wore silk shirts and cloaks, the higher officers carrying shields decorated with strips of silver indicating their rank; while many of the soldiers wore leopard skins or decorations of lions' manes.

In addition to his work on the transport, Swayne continued his map-making; he arranged with Gleichen that the latter, who was the intelligence officer, should make a sketch map of the route and Swayne himself sat up many evenings taking shots of the stars, to fix positions for latitude and longitude, with a large transit theodolite. The position he finally arrived at for Addis Ababa was about 13 miles from the position shown on the existing maps, and he was gratified a few months later, on meeting the French explorer Captain Marchand, who had carried up a similar line of survey, to find that the latter's calculation agreed very closely with his own. Both were within 1½ miles of the position fixed later by more accurate methods. Mr. Rennell Rodd, in his final report, refers to Captain Swayne as "an extremely hard-working officer who had spent a great deal of time in scientific and astronomical observations." This report was "received with satisfaction" by the Marquis of Salisbury, then Prime Minister and Secretary of State for Foreign Affairs, and a copy was communicated to Swayne. Swayne also received the permission of Her Majesty to accept and wear the Order of the Star of Ethiopia, a very high and rare honour conferred on him by the Emperor Menelik II.

This was the last active work done by Harald Swayne in East Africa.

Among the results of the Rennell Rodd Mission, a British representative was appointed to the court of King Menelik and an agreement was arrived at as to the boundary between the Abyssinian, French and British spheres; the boundary between the British and Italian spheres had been defined on the map in 1894. Another change, which had wide-reaching consequences, was the transfer of the control of Somaliland from the Indian Government to the Foreign Office. This change adversely affected Harald Swayne as when difficulties arose in 1900 with the "Mad Mullah" the home authorities called on his younger brother, Eric Swayne, to put down the disturbance which had arisen. Eric Swayne, after leaving his brother on the completion of their work on the survey in 1892, had taken service under the British East Africa Company and was employed in the difficult and confused fighting in Uganda which was terminated by the capture of King Mwanga of Uganda and

King Kabarega of Unyoro. Eric Swayne was given the duty of escorting the two Kings to the Seychelles and while at Aden, in November, 1900, on return from this duty, was ordered to Somaliland to raise a local levy to deal with the Mullah. As the Home Government would not agree to a permanent occupation of the country, the only course was to try to capture the Mahdi's person. Eric Swayne carried out two winter campaigns in 1900–01 and 1901–02; in the first year he defeated the Mahdi's army and forced the Mahdi to escape into the Haud, the following year he had a hard-fought battle at Erigo, south of the border of Somaliland, but the Mahdi again escaped. Eric Swayne was then invalided with fever but returned later as Commissioner and Commander-in-Chief of Somaliland and later again was appointed Governor of British Honduras and received the K.C.M.G. The next two winters fighting was resumed by much larger forces under Brig.-General Manning and Major-General Sir Charles Egerton, the latter gaining a victory at Jidbali and driving the Mahdi into Italian Somaliland. Harald Swayne was intensely interested in all these happenings, and made several attempts to go on service. He offered to serve under his brother in any capacity, but he had recently been promoted Major and was thus senior to all the officers who were detailed to accompany Eric Swayne, and the appointments in charge of the transport were filled by junior officers. In 1893, when Harald was offered employment, he was incapacitated by fever, but in this year he published the third edition of his book, with a preface explaining the reasons for the revolt of the Mullah. When public interest was aroused by the news of the fighting at Erigo, *The Times* published a statement that the country had never been surveyed. Actually the survey by the brothers Swayne was very complete and gave ample information, but their maps had been treated as confidential both in India and in the Intelligence Office in London. Swayne got a question asked in Parliament but only obtained an evasive reply, that the work done by the brothers was a "reconnaissance" and not a survey, but in a subsequent debate in the House of Lords, Lord Curzon made the statement already referred to, that Major Harald Swayne was the best authority on the Somaliland interior. With this we may leave this part of the story.

In the intervals between his visits to Somaliland and after he left the country in 1897, Harald Swayne was employed in India on some of the many jobs open to R.E. officers. In 1898 he was on plague work in Bombay and later was temporarily Chief Engineer to the Calcutta Corporation and Under-Secretary, P.W.D., Bengal. In 1899 he was employed on famine relief work in the Nizam's territory and in 1900 conducted an enquiry into allegations against an English Civil Servant in that area. Swayne's report showed that these accusations were unfounded and he received a letter of thanks from the Resident for his work. He was C.R.E. of various areas as

Major and Lieutenant-Colonel, and in 1911, when he had been promoted Substantive Colonel, he was made C.R.E. of the 8th (Lucknow) Divisional Area, which included the large stations of Lucknow, Cawnpore, Benares, Allahabad and Calcutta. He retired on an Indian pension in June, 1914.

He spent most of his leaves in travel and exploration; in 1903 he marched from Ob station on the Siberian railway into the highlands on the border of Mongolia and was successful in getting good heads of the Siberian wild sheep, the "Ovis Ammon"; he published a record of this trip under the title *Through the Highlands of Siberia*; in 1904 to 1907 he marched from Beira to the Zambezi; and in 1910 visited Nairobi in Kenya and marched through Uganda to the German border at Toro.

In 1911 he visited Gilgit for sport, fifteen marches from the railway, and in 1912 visited Leh and the West Tibetan border, twenty marches from the railway; in the same year he was sent on duty into West Tibet proper, crossing from Darjeeling into Chumbi. In 1913 he made his fifth visit to Kashmir, marching and hunting in mid-winter, and in 1914 he celebrated his retirement by a trip to China and Japan, returning *via* Siberia.

The outbreak of the Great War in August, 1914, thus found him on the retired list, but in January, 1915, he assisted his wife to form a hospital, known as Mrs. Swayne's Hospital, at Cherbourg, under the French Red Cross and worked there until in August, 1915, he was given the Command of the 5th Labour Battalion of the R.E. Pioneers. This battalion was employed in the neighbourhood of Ypres on railway construction; for this work Swayne was twice mentioned in despatches and given the C.M.G., a somewhat belated decoration which, however, gave him much satisfaction. In August, 1917, the strength of the battalion was reduced to one company, and Swayne, after some work at the Ministry of Food, was employed by the War Office after the Armistice in lecturing to the troops in the Army of Occupation. His last duty in this capacity was on the 27th October, 1919.

On reversion to civilian life he bought Burghill Court, near Hereford, where he lived for some years, but he travelled extensively on the Continent and built himself a villa at Alassio, which he afterwards let to Sir Edward Thackeray. He occupied himself in lecturing and writing on travel and geographical questions in various scientific publications and in the press. He had also a gift for sketching and when a young officer, had given up part of his leave to attend art schools in Paris; most of the illustrations in his books are from his own sketches.

Swayne was three times married, first in 1894 to Katherine Aimée, daughter of Sir William Holmes of British Guiana, second in 1907 to Amy Christina, daughter of R. A. Swayne, Esq., of Tillingdon Court, Hereford (she died in 1936), and third in 1940 to Lorna Jean,

only daughter of the late David Newman, F.R.C.S., and ward of Major-General Telfer-Smollett, Governor of Guernsey. By his first wife he had one daughter, now the wife of Lieut.-Colonel Winder, R.A.M.C. His third marriage ended in tragedy. The marriage had been arranged to take place from Government House, Guernsey, on the 30th January, 1940, but on the 22nd Swayne tripped over an obstruction in the hall of his hotel and falling heavily fractured the femur of his right leg. He was taken to hospital, where a few days later the marriage took place very quietly. He seemed to be making a good recovery and a house was taken to which he could be moved, but a few days before he was leaving hospital pneumonia supervened and he passed away quietly in his sleep on the 14th April, 1940.

The writer of this memoir got in correspondence with Colonel Swayne in connection with the preparation of Volume IV of the *Corps History*, when Colonel Swayne supplied a series of letters giving details of the work of himself and other R.E. officers in Somaliland. Swayne was at the time in Italy, but he came to London early in 1939 on his way to the World's Fair at New York, and very kindly arranged to get out of store some of his records and a copy of the map of Somaliland prepared by his brother and himself. The writer then had a very interesting interview in London and discussed many points of the draft he had prepared for the *History*, all of which had been checked by Swayne in considerable detail. It is not possible after a short interview to give any personal idea of the character of the subject of this memoir, but the short record given above is abundant testimony to the tact and skill he displayed in dealing with all classes and to the respect and affection he earned, not least among his Somali followers, who he always spoke of as his friends.

I may close this record with an extract from a letter from his wife, "I should so much like some reference to be made to his wonderful kindness of heart and generosity. I have never in all my life known anyone for whom I had a greater admiration or who had such a wonderful outlook on life."

In his Will, Colonel Swayne included the following clause:

"I desire that a parcel of records comprising documents relating to my Military Service copy of survey sheets of British Somaliland and astronomical and other documents in connection with the Political Mission to the Emperor Menelik of Abyssinia in 1897 should be sent to the Secretary, Institution of Royal Engineers, Chatham, for the use of the Editor of *The Royal Engineers Journal* for obituary purposes or the Royal Engineer Museum at Brompton Barracks, Chatham."

It is hoped that the above memoir will be accepted as a fulfilment of the first of these objects. W.B.B.

All Reviews of Books on military subjects are included in the provisions of K.R. 535c (*1935*).

BOOKS.

(Most of the books reviewed may be seen in the R.E. Corps Library at Brompton Barracks, Chatham.)

THE ART OF MODERN WARFARE.

By COLONEL HERMANN FOERTSCH.

(Translated by T. W. Knauth.)

(Veritas Press, New York. Price $2.75.)

THIS is a translation of *Kriegskunst heute und morgen* (literally *Art of War To-day and To-morrow*), published under the name of a Colonel of the German General Staff in July, 1939. (A brief notice of the original was given in the *Army Quarterly* of October, 1939.) The book is a short (250 pages), thoughtful appreciation of war as the German General Staff wish other nations to believe it is waged and as we have since seen it carried out in Poland and France—except there is no mention of the " Fifth Column," and certain other vital factors in Germany's success, to which reference will be made later.

The translator must be congratulated: he not only understands the two languages perfectly, but also the subject. Only one military expression, " hinhaltender Widerstand," for which there is no equivalent in English military language, might have been better rendered than by " dilatory resistance ": " false resistance " would be nearer, on the analogy of " false flank."

The book was possibly compiled by order and, like Bernhardi's *War of the Future* before 1914, calculated to intimidate and alarm possible enemies at the thought of what was in store for them. Nevertheless there is much of value in it and one wishes it could be read by all of our rulers who have not been soldiers. Most of its maxims have undoubtedly been followed in the present war.

It is divided into three parts: Part 1—War; Fundamentals and Definitions; Part 2—The Wars of Yesterday—What they were like; and Part 3 (two-thirds of the work)—Modern Warfare.

In the first part the author follows Clausewitz in saying that war is a continuation of policy and that military considerations must give way to political, with the wise addition that " difficulties would disappear if, in times of peace, statesmen would learn to think as soldiers, and soldiers as statesmen "; and that the military command must pay due regard to domestic and economic conditions. On the other hand, he points out that Moltke I. said " politics must not intrude into the operations."

" The greatest lesson of history, it has been said, is that

nobody learns from it. But lost wars never let you rest and force you to reflect, while victories always harbour the danger that lies in the self-confidence of the victor."

Strategy must aim at annihilation. An enemy must either be blasted to pieces or surrounded. But whereas in former days strategy prepared the way for battle, tactical success must now provide the opportunity for strategy; but again, as Moltke I. said, "a tactical success is only really decisive if it is gained at the strategically correct spot."

Only one allusion to sea-power can be found. The paragraph is worth quoting:

> "In coming wars economic pressure will commence in the first hour. There will be no waiting for a military decision. A commercial blockade, however, is only possible after the command of the sea has been won, even though it be only for certain localities and for a certain time. Operations from the air . . . can be decisive only when his (the enemy's) military defences, in other words his air defences, have been conquered, or at least put out of action for a specific time and locality."

Offence and defence, total war, lightning war, propaganda are all discussed.

The survey of "war of yesterday" in Part 2 begins with the "Wars of clans and tribes," and, omitting the infantry age, passes to the wars of mounted men, of the *Landknecht*, mercenaries, kings, nations and peoples. The remarks on 1914–18 are disfigured by Nazi colouring: the old lie is repeated that "The Central Powers only desired to remain intact. Their political war aims, therefore, were and remained defensive." It is for once admitted that "the Germans finally succumbed to the Allied counter-offensive, though economic pressure and propaganda contributed to the defeat of the finest army in the world."

In Part 3, in discussing "modern warfare," Colonel Foertsch provides a number of wise saws: "Politics as the progenitor of war always sets new tasks"; "no new war commences where the last left off; nevertheless it is not in vain to study the experience that the last war brought." "Experiences can be lost. It is a fault." "Imagination is not planless reflection . . . it is the gift of understanding and re-living and, even more, of looking forward, of seeing in the mind whither events may, or must, take us." "Standstill means retrogression." "Only the possession of an overwhelmingly superior weapon, of a technical or chemical nature, against which the adversary has no defence, could justify the hope of a war of short duration." "Psychological influence and economic pressure . . . alone will never bring about a decision. There must be a final push of arms . . . the smashing powers of the Allies' arms

knocked them [the staggering German people] into submission."

He does not swallow whole the Italian Douhet theory (for winning the war by air forces alone): "limits have been set to them by nature herself, by means of the weather and the law of gravity."

In discussing small *versus* large armies and mechanization, he says: "Decisive results can only be attained in war by small mobile forces which can act quickly before the larger masses appear on the scene."

The bayonet is completely out of date. Hand-grenades may be useful, the rifle is no longer the principal weapon of the infantry, which is now the light machine-gun. The reason for the different kinds of divisions is to obtain mobility for some for offence and high defensive powers for others. "Tanks are expressly a weapon of attack," and he warns us of hundred-ton tanks, with the remark that "the most effective opponent of the tank is another even stronger." "To scatter a few tanks over a wide frontage will never lead to success." "The greatest danger to tanks, besides superior enemy tanks, is that of land mines."

The question is put, whether the tank should become "a separate, great and self-contained part of the armed forces," or remain auxiliary? Horsemen (mounted infantry, not cavalry) will still be required for reconnaissance, for the air brings "a series of snapshots and not continuous observation." The main work of the engineers will be making and removing obstacles and bridging and roads. Smoke screens have increased in importance. Surprises in the use of gas and chemicals, for example spraying poisonous liquids on resting or marching troops, are possible. Air forces will provide "vertical encirclement." Parachute troops are a recognized entity, "their tactical employment in thickly-settled, cultivated country is limited [unless backed up by Fifth Columnists]." The long-range (Paris) gun has been superseded by bomber aeroplanes.

As future weapons, the only suggestions are "death rays and bacteria, one-man torpedoes, subterranean burrowing machines and huge stratosphere airships."

After this flight of fancy, the book tails off into "tactics of modern warfare" and the platitudes of the service regulations, the only new feature being the "dilatory resistance" earlier referred to. Its object "is to avoid the decision sought by the attack and gain time while inflicting all the damage it can on the enemy. . . . The principle on which this form of fighting is conducted is a wide extension of the line at the expense of depth. The fight will be in the main carried on by the artillery and the heavier infantry weapons. . . . The chief responsibility of the infantry and their light machine-guns will be to protect observation posts and fire positions of the long-range guns. . . . Obstructions of every kind will assist in this form of fighting."

In this Prussian Colonel's book we miss most of the weapons of Germany's real armoury, not only the Fifth Columnists, "tourists" and ships laden with combatants introduced before hostilities into the harbours of future victims, but lying diplomacy, peace pacts never intended to be respected, forgery of documents, bribery and corruption of subjects of future victims, sabotage in peace-time, kidnapping of important officials, misuse of white flag, misuse and violation of the protection of the Red Cross emblem, misuse of opponents' uniforms, terrorism, bombing and machine-gunning of civilians, and collective punishment (forbidden by the Hague Rules, to which Germany subscribed), making the inhabitants responsible for the safety of bridges, communications, etc., and doping (by pervetin, etc.) of combatants to make them temporarily courageous.

J.E.E.

A KEY TO VICTORY.

A STUDY IN WAR PLANNING.

By LIEUT.-COLONEL CLIVE GARSIA, D.S.O., M.C.

(Eyre and Spottiswoode, London, 1940. Price 10s. 6d. net.)

In these days of totalitarian war, any book with the above title arrests attention and merits the closest consideration. Lieut.-Colonel Garsia maintains that a system of "automatic planning" is the surest guide to victory and supports his contention by analyzing the first two battles of Gaza, and setting forth the plans which from his system would have ensured crushing victories in these battles. No soldier will cavil at the stress laid on the importance of exhaustive "appreciations"—to give the term "automatic planning" the name by which it is usually known in the Service. This part of the book is well worked out, as also are the descriptions of the battles and of the proposed plans of action. It is with Lieut.-Colonel Garsia's deductions that the military reader with war experience will join issue. Before making the plan Lieut.-Colonel Garsia analyzes very carefully the pros and cons regarding strength of forces, terrain, enemy's intentions, etc., and then from these deductions he has an "invisible stage" in which he decides his plan. He stresses the dangers to be met with when writing an appreciation from *parti pris*, special pleading, literary ability and the wrong choice of object, but maintains that by his system, the careful and logical study of the various analyses will produce the best plan. This might be so, if it were a question of facts, but in war most of the data available are vague and uncertain, as, *e.g.*, the detailed disposition and strength of the enemy's forces, moral of his troops, ability of his commanders, etc., etc. Experienced soldiers will differ widely as to the relative importance to be attached to each factor, and it is the province of the C.-in-C. to select the plan of action he considers most promising.

Incidentally, Lieut.-Colonel Garsia in his plans for the Gaza battles advocates an unlimited objective—a course which on the Western Front was taboo, as its adoption in the early stages of the last war led to heavy losses.

Space is not available for criticizing in detail the plans proposed for the battles. Suffice it to say that in the First Battle of Gaza, fought on the 26th March, 1917, more energetic action on the part of a divisional commander, and obedience to orders by a brigadier, might easily have turned this action into a success—the more so as the Turkish commander in Gaza thought that he was beaten.

As regards the plan proposed for the Third Battle of Gaza, any commander who had experience of the losses incurred in Gallipoli and France from frontal attacks

was justified in refusing to pin his hopes of victory on a break-through on a front of a mile with the uncaptured town of Gaza on his right and the sea on his left. These also are the opinions of senior officers, who were actually engaged in the battles.

In the latter part of the book Lieut.-Colonel Garsia advocates that an inter-allied Committee, including *inter alia* a Major-General (in close touch with the C.-in-C.) and a lawyer, should formulate plans for winning this war. It is not understood what weight a lawyer trained in logic would add to the deliberations of the Committee, unless he was at the same time an experienced student of war.

Further, Lieut.-Colonel Garsia considers that the C.-in-C. should either accept the Committee's plan of action or tender his resignation.

The General Staff have since their formation early in this century been entrusted with the duty of preparing plans of campaign, and there is no reason to suppose that with the Naval and Air Force Staffs they are not hard at work at present on such plans. Offensive action must however, of course, await the formation, training and equipment of armies of adequate size.

The C.-in-C., who has been selected by the Government as worthy of their confidence and of that of the Forces, will no doubt carry most weight with the Government regarding the plan to be adopted.

The War Cabinet, with numerous committees, are at present engaged in thrashing out the best methods for speeding up and exerting our maximum effort to win the war, but the plan of campaign is the province of the trained staffs of the Forces.

This book is of value to army officers, especially to those studying the Palestine campaigns, as also to students of the Staff Colleges—it does not, however, supply a key to victory which the Services do not already possess.

C.G.F.

MILITARY SCIENCE TO-DAY.

By Bt. Lieut.-Colonel Donald Portway, R.E.

(Oxford University Press. Price 4s. 6d. net.)

This volume compresses in a small compass and readable manner a mass of detailed information regarding the application of modern science to artillery (including anti-aircraft), engineering (field and coast defence), mechanization, tanks, signalling and chemical warfare, and it also touches on the work of the R.A.F. Each subject is prefaced by a short historical sketch, and the improvements effected in the last war are noted, as, for instance, sound-ranging, flash-spotting, predicted artillery shooting, etc. Published early this year, no mention is made of the magnetic mine nor of parachute troops, but the author points out that the German doctrine envisages the use of armoured divisions with boldness and daring, and the rapid exploitation of any success. He does not, however, draw attention to the efficacy of combined dive-bomber and tank attacks. His judgment that much of the money spent in this country on A.R.P. and safety measures would have been better expended on offensive armaments will probably be shared by most soldiers.

The book is illustrated by some forty excellent photographs, and will appeal to the general as well as to the military reader, who wishes to bring his knowledge of military science up to date.

C.G.F.

WHY FRANCE LOST THE WAR.

A Biologic and Economic Survey.

By A. Reithinger.

(Veritas Press, Inc., New York. Price $1.25.)

This brochure of 75 pages, translated from the German and written presumably by a German, purports to prove that owing to lack of men and money France could

not win a three years' war. This thesis is worked out in great detail and supported by 22 analytical tables. According to Herr Reithinger, France started the war with only one-tenth of the foreign loans she possessed in 1914, and could not meet one year's war expenditure. He does not mention, however, how Germany, who at the outbreak of war owed large sums abroad, can cover her war-time costs.

On the score of man-power, Herr Reithinger is on surer ground. Compared with Germany, France is very deficient of males of military age, and she has not done her best to placate her large alien population. She imposes on them the duty of bearing arms, whilst denying them the privileges of citizenship. This and Fifth Column activities are no doubt two of the many reasons for the breakdown in French morale, and for the present lamentable situation. Figures can, of course, be made to prove anything, but it is the spirit that counts. This work stresses too strongly material reasons, and it cannot be taken very seriously. C.G.F.

THE FIGHTING SOLDIER.

By MAJOR W. A. S. DUNLOP.

(Heinemann. Price 1s. 6d. net.)

This book is published with an introduction by Field-Marshal Sir Edmund Ironside which commends it to all serving officers of the British Army, and Major-General Sir John Gellibrand, late Commander 3rd Australian Division, A.I.F., has also written an appreciative foreword.

The book is written primarily for young officers joining an expanding Army from civil life, but it forms also a valuable *aide-memoire* on those many vital points which require the closest attention by all regimental officers if they are to be successful as leaders, and if they have the interests of their men at heart.

Apart from two chapters, one dealing with other units as they appear to the infantry, and one dealing with weapon characteristics, the book is very well worth reading carefully. For more senior officers, the rest of the book will provide an excellent basis for instructional lectures. For more junior officers the book is full of useful tips.

The author served in the last war with the Australian Forces and the points made are presumably based on experience of service with Australian troops. It is therefore suggested that British service officers reading the book should do so critically and analytically. There are one or two points with which most officers would join issue, for instance, a suggestion is made that when sarcasm is employed it should be employed with discretion. Most officers will agree that the use of sarcasm by an officer when dealing with soldiers is absolutely unpardonable.

Apart from such points with which the reader may not agree, there is really an immense amount of useful matter compressed into a very small space. The main attraction of the book lies in the fact that the author, as a good regimental officer, has studied in the greatest detail the outlook and needs of the soldier and has expended much thought in determining for himself how he can get the best out of his unit, and at the same time ensure that his men get a square deal. L.F.R.K.

A NEW MAP OF THE KARAKORAM.

(Royal Geographical Society. Price 5 Rs. = 7s. 6d.)

The Royal Geographical Society has published this map, drawn by Mr. F. J. Batchelor, under the direction of Professor Kenneth Mason (Lieut.-Colonel, R.E., retired). It embodies the Range and Peak names approved by the Karakoram Conference of 1937, and includes all published results up to Mr. Eric Shipton's expedition of 1937. It extends from longitude 74° 5′ to 78° 55′ and from latitude 34° to 37° 27½′. The map is printed in eight colours on a sheet with engraved surface 22·7 inches by 20 inches.

The system of colouring is unconventional and follows the principles described in

a note to the International Geographical Congress of 1934 and it resembles much that used in recent Norwegian maps, adapted to the higher altitudes. The principles followed are, shortly:—The layer system is abandoned for the heights, reserving the possibility of using them for the valley bottoms. The mountain slopes are accentuated by colouring in brown on a ground tint of yellow, with blue shading for the snows and a general oblique purple shading from the north-west, though this is varied somewhat to suit the ground. Contours are shown at 2,000-foot intervals and many spot heights are given. The result of this system is to present a very clear and easily-read map, beautifully printed and finished in every way; a most valuable contribution to the geography of these parts. The scale is 1 : 750,000 or 11·8 miles to 1 inch.

The map is strongly recommended to anyone travelling in the mountains beyond Kashmir for sport or any other reason. The price is 7s. 6d. or 5 rupees to the public, and to Fellows of the R.G.S. 6s. Copies of the preliminary edition, without mountain names, may be bought from the Office of the Society for 2s. 7d. G.R.P.

MILITARY MAPPING AND REPORTS.

By Brigadier-General W. Allason, D.S.O.

(Duckworth, 3 Henrietta Street, W.C.2. Price 2/- net.)

The somewhat ambitious title of this book covers in the space of 24 pages short descriptions of grid referencing; enlargement of an existing map by means of two co-ordinate scales or "Romers"; and the construction of roughly-scaled panorama sketches. The value of the latter is well-known; but the author is perhaps stretching their utility by describing in some detail how a number of such sketches can be combined to construct a contoured map. A force operating in unmapped country would certainly require maps; but would with equal certainty not obtain them by this method.

The book contains a number of misprints, particularly in references to the plates. It is in no sense a substitute for the official *Manual of Map Reading*, but might have some value if read in conjunction with the *Manual*. M.H.

MECHANISM AND THE KINEMATICS OF MACHINES.

By W. Steeds.

(Longmans. Price 18s. net.)

When asked to review this book the writer was badly frightened by the title, and in fact put off tackling it until a spell of night duty came along! The fear, however, was then soon dispelled and the book read with increasing interest.

The author states his object is "to provide an adequate treatment of the kinematics "of machines and the study of mechanisms as mechanical contrivances while "avoiding excessive detail and encyclopædic comprehensiveness" and "to steer a "middle course between unduly academic treatment on the one hand and excessively "detailed descriptive treatment on the other hand." He has succeeded in maintaining this happy balance, and the book can be read with interest by any Sapper officer with mechanical leanings even if his mathematics have acquired considerable rust. The book is well planned, certain more advanced portions of the text being starred, to be omitted on the first reading. A goodly number of exercises are given.

After opening with some gentle chapters on velocities and acceleration, the author deals very clearly and in a most interesting manner with the constraint of bodies and geometric design, a subject not often included in engineering textbooks. This leads into a study of mechanisms followed by the theory of toothed gearing and gear trains. A most interesting chapter is devoted to variable speed gears, and a final one to miscellaneous mechanism.

This book is recommended to students as an introduction to machine design.

F.M.H.

STRENGTH OF MATERIALS.

By ARTHUR MORLEY, O.B.E., D.SC., M.I.MECH.E.

(Longmans, Green and Co. Price 15s. 6d.)

The ninth edition of this work, which first appeared in 1908, completes 52,000 copies. In spite of a large mass of new, and valuable, material, it has been possible to retain to a very large extent the chapter and paragraph numbering of previous editions—a matter which greatly simplifies references in other works bearing on the same subject.

The work is so much of a standard treatise that there must be few in the engineering world unacquainted with it; but to such it may be said that the materials referred to comprise iron and steel in their many shapes and forms, other metals, timber, stone, cement and concrete.

The book is invaluable to the engineering student. Practising engineers who, it must be confessed, rely generally on rules and formulæ in pocket books, will find it a useful reminder of what they learned in student days, as well as an eye-opener as to research carried out all over the world since strength of materials was an examination subject for them. Manufacturers and others will find it indispensable.

The amount of industry and research that has gone to the making of the present edition is truly enormous, and it can only be said, in no trite or flippant manner, that it is the last word on the subject.

F.C.M.

KENYA AND UGANDA RAILWAYS AND HARBOURS.

The Report of the General Manager, Brigadier-General Sir Godfrey Rhodes, C.B.E., D.S.O., late R.E., for the year ending December, 1939, has now been published. It is unnecessary to comment on the mass of statistics included in the Report, but two items on the treatment of natives are worthy of mention. As an experiment it was decided, in the construction of a new station, to make use of a poor type of labour that had walked in some hundreds of miles looking for work. A special diet was given to these men and a course of quinine and other drugs, and, in a very short time, their physique had improved to such an extent that their output of work became not inferior to the better type of labour employed in the Protectorate. In the second experience it was discovered that certain members of the marine staff employed on the lakes were suffering from night blindness. As the men fed themselves, diet trouble was suspected, and an issue of one ounce of cod liver oil a week to all quartermasters and pilots has resulted in the disappearance of all signs of night blindness.

F.E.G.S.

MAGAZINES.

REVUE MILITAIRE SUISSE.

(*March*, 1940.)—*Quelques réflexions sur la discipline dans le Corps des Officiers.* By Colonel Montfort. A reminder to the officers of a national army recruited by regions that discipline is the mainspring of the army. It is difficult to attain all at once a high standard of obedience to orders where nearly every member of a unit knew his fellows before enrolment. Initiative and personality must be combined with discipline. Camaraderie among the officers need not hinder discipline, it ought to foster it.

Le cours de répétition d'hiver de la brigade de Montagne 11. By Lieut.-Colonel Erb. The continuation of the account of this outdoor exercise. The training was thoroughly prepared and carried out. The men were fully equipped and made their ascents and marches under active service conditions. The weather was stormy, and towards the close of the training a disastrous avalanche overwhelmed a column of porters, causing the death of three officers and one serjeant. A full account of the mishap is given.

Some notes on the special Alpine equipment of the men are added.

La tenue de nos officiers. By Lieut. Lattion. Another article on the conduct and bearing of officers, especially the subalterns, by one of themselves.

Commentaires sur la guerre actuelle. The last stages of the heroic resistance of the Finns is reviewed. The continual reinforcement of the Soviet attack wore down the Finnish defenders, who were unable to relieve their troops and unable to shorten their line. Their rear communications were devastated by Russian air raids.

Once again, however, stress is laid on the failure of the Russian parachute troops to gain any result; the unfortunate descendants from the air were practically annihilated. This method of warfare had been made much of in the Russian Army.

(*April*, 1940.)—*Avec les troupes frontière.* By Major Rochet. A brief account of the state of mobilization of Swiss frontier troops, and a few comments on the way in which the various age groups settled down together. There is no mention of the process of mobilization, or time taken for completion.

Pour preserver nos soldats des maladies infectueuses; la vertu des vitamines. By Dr. Sandoz. A medical article.

Commentaires sur la guerre actuelle. The commentary this month includes some further lessons from the Russo-Finnish war. The mobility of the Finnish infantry and their variable organization are remarked upon. Each battalion had anti-tank detachments—about a company in strength—told off solely for the destruction of tanks by land mines or petrol bombs.

The Finns made the most of natural and artificial obstacles to tanks; wide belts of *abattis* in the forests were favourite devices. For anti-aircraft fire, the 76-mm. gun was found to be too ineffective; calibres of 105 or 150 mm. were preferred.

The Finns suffered heavily from the neglect of air raid precautions.

Chronique étrangère: La prise de Varsovie. Extracts from an account by General Blaskovitz, who commanded the German Eighth Army in Poland. A very one-sided version, in true German fashion; exaggerating the forces of the Poles, and belauding the precision of the German evolutions. It is much too highly coloured to convey any accurate idea of the operations.

W.H.K.

RASSEGNA DI CULTURA MILITARE
(now RIVISTA DI ARTIGLIERIA E GENIO.)

(*February*, 1940.)—*Il pensiero militare italiano dalle guerre napoleoniche ai nostri giorni.*

General Maravigna concludes his article on the development of military doctrine in Italy. In this instalment he discusses contemporary ideas. Up to the time of the World War the leading principle was that of the "Nation in Arms." Scientific progress brought about the perfection of aviation, the improvement of the submarine and of radio, the invention of the tank, and the increased power of modern weapons; all this led to a state of affairs that may be described as the "Nation organized for War." The change began in the course of the World War and has continued ever since.

Gli ultrasuoni. Loro attuali e future possibilita d'impiego per applicazioni belliche. By Lieut.-Colonel Gatta.

Just as in the case of visible radiations, there are two gamuts of invisible radiations, known, respectively, as infra-red and ultra-violet, so, in the case of elastic audible waves, there are inaudible waves known, respectively, as infra-sounds and ultra-sounds. The former have a frequency between 1 Hz. and 15 Hz., the latter have a frequency exceeding 25,000 Hz. Waves intermediate between these limits are audible to the normal ear.

The writer describes the effect of the outer ranges of waves, both physical, chemical and biological, and suggests the possible use of ultra-sounds for war-like purposes. Just as modern science has enabled us to create artificial lightning by means of high electric potentials, it also seems possible that, in course of time, powerful sources of energy may be discovered that will be capable of causing artificial earthquakes.

The subject is being keenly studied in Italy, America, Germany, Britain and France.

(*March*, 1940.)—With the current number, the *Rassegna di Cultura Militare* reverts to its original form and re-assumes the name of *Rivista di Artiglieria e Genio.*

L'esercito sovietico nella campagna del 1920 in Polonia. By General Ago.

The recent Finnish war recalls to the writer the first campaign fought by the Soviet army, i.e., against Poland in 1920. Having defeated the armies of Kolchak and Denikin, the Soviet army concentrated against Poland in July of that year. The Polish army, spread over a wide front, was driven back to Warsaw and the line of the Vistula.

But Marshal Pilsudski, the Polish commander, did not lose heart, and delivered a counter-offensive, which saved Poland. With one army (the 5th) operating against the Russian right, he struck the main blow with 5½ divisions against the Russian centre. The campaign terminated with the complete defeat of the Russians.

General Ago discusses the reasons for the Russian defeat, which was largely due to the inferior generalship of the Russian commanders and the poor morale of their troops. In his opinion there has been little improvement in the twenty years that followed the campaign.

L'alimentazione a metano degli autoveicoli. By Colonel Amione.

Great efforts have been made in Italy to find a substitute for petrol as a fuel for motor vehicles, and so reduce the imports of that commodity from abroad. Colonel Amione discusses the advantages and disadvantages of methane (CH^4), which can be obtained in Italy in large quantities, both from natural and artificial sources. In 1939 the production of natural methane amounted to 20 million cubic metres, about half of which was used in auto-traction.

Some of the advantages of methane are that it leaves no incrustation, it does not dilute the lubricant and it leaves no unpleasant fumes. On the other hand, in its gaseous form it is extremely bulky. A kg. of petrol, occupying 1·3 litres, has the same calorific value as 1,115 litres of methane.

Methane can be transported in three ways:—(*a*) by gas pipes; (*b*) in cylinders containing compressed methane; (*c*) in special receptacles containing liquid methane. These methods are discussed in turn. So far, method (*b*) is the only one that can be used in practice for motor vehicles, but the weight of the cylinders is an obstacle to the general use of methane. It is not considered practical, as yet, to use it in army vehicles.

The total consumption of methane by motor vehicles in Italy in 1939 was ten million cubic metres. This is not a large amount, but it represents a saving of 10,000 tons of petrol. A.S.H.

ANNALI DEI LAVORI PUBBLICI.

(*February*, 1940).—*Esame critico dei sistemi e metodi per le fondazioni in terreni cedevoli.* By Dr. Palagi.

After a reference to the principal characteristics of yielding soils, the writer describes a series of experiments conducted to determine the compressibility, resistence to crushing, and other properties of the soil. He goes on to deal with different systems used in practice. The use of rafts of reinforced concrete is perhaps the most satisfactory, provided that the centre of gravity of the building comes vertically above the centre of the raft. A raft of masonry with iron bonds was used in a bridge constructed in Rome in 138 B.C.

With regard to the use of piles, many constructional engineers are not up to date, and use monkeys suitable for wooden piles when driving concrete piles many times heavier. The weight of a monkey should not be less than half the dead weight of the pile that it drives.

Studio generale sui movimenti franosi in provincia di Catanzaro.

Dr. Montanari describes the main movements to which rocky strata in the province of Catanzaro are subjected, as well as the seismic disturbances that occurred in the Calabrian peninsula between 1873 and 1908. These earthquakes caused landslides as well as damage to buildings. Many landslides would appear to have been caused by the denudation of the hillsides, aggravated by deforestation.

(*March*, 1940).—*Crollo e ricostruzione del ponte della vittoria a Pisa.* By Dr. de Simone.

The construction of a bridge of three masonry arched spans across the Arno at Pisa was began in 1932 and completed in February, 1934. Caissons were used for the pier foundations, which were sunk by the compressed air system. As it seemed doubtful whether the clay in the river bed would carry the load of the piers, a modification was carried out by spreading the footings of the foundation and lightening the weight of the bridge itself. But even during construction there was some settlement in the abutment and pier foundations (particularly in the left-hand pier); this settlement increased during the year 1934, especially in November and December. On the 22nd December, immediately after a heavy flood, the left pier suddenly sank, bringing down the left arch, which was followed almost immediately by the central arch, and then by the right arch.

A detailed account is given of the causes of the failure.

The bridge was subsequently reconstructed on the same alignment. To avoid striking the wreckage of the old piers, the central span was considerably increased. The new piers were founded on reinforced-concrete piles 37 metres long: the spans consisted of reinforced-concrete arches. The completed bridge was opened to traffic in December, 1939.

Studio generale sui movimenti franosi in provincia di Catanzaro.

Dr. Montanari continues and concludes his study of the Catanzaro earthquakes and landslides. He makes proposals for preventing percolation of rain-water into the soil by the construction of catch-water drains along the hillsides and by other methods.

Vasto programma di opere idrauliche ed agricole nel Portogallo.

The climate of Portugal is characterized by heavy downpours of rain causing spates in the rivers, and by long periods of drought during the summer months. Engineering works have therefore been planned to reduce the surplus discharge in flood time, and to accumulate a supply of water for hydro-electric purposes and for irrigation during the dry season.

This article contains a description of works that have been planned or constructed in recent years. One work included in the construction programme is a dam in connection with an irrigation scheme in the Mondego district. Three gravity dams have been erected near Lisbon, of which two are in the valley of the Sado, and the third on a tributary of the Tagus near the Spanish border. These are connected with hydro-electric schemes.

Various types of dams have been constructed: masonry, rock-fill, and dams of rammed clay. In one case a combination of all three methods has been adopted, the wetted surface being lined with asphalt.

A.S.H.

THE MILITARY ENGINEER.

(*May–June*, 1940).—*Russia in the Past.* By Lieut.-General Uzefovich.

A historic sketch of Russia under Tartar rule and under the Romanov dynasty up to the death of Czar Nicholas II.

Engineering Problems of Marine Brigades. By Captain McAlister.

The marine brigade consists of 7,558 officers and enlisted men, Marines and Navy, of which the engineer battalion with a strength of 508 forms an integral part. The company equipment in the marine battalion is essentially the same as that assigned to similar units in the combat regiment of engineers. Vehicles consist of tractors and trailers. Power tools are classed as "special equipment," and the decision of how much of this equipment is to be carried rests finally with the force commander.

The works on which the marine engineer battalion is likely to be employed are those in connection with a landing (*e.g.*, map-making, removal of obstacles, clearing, construction of piers), water supply and storage, preparation of aviation grounds, demolition, camouflage, etc.

The Quartermaster Corps in Peace and War. By Major Brunson.

The Quartermaster Corps has a peace strength of 905 officers, 14,121 enlisted men and 44,715 civilian employees. Its main duties are the supply, development and standardization of transportation, animals, construction projects, and items of clothing and field equipment. This article gives a detail of its units and their distribution.

The Federal Bureau of Investigation Guards against Espionage. By J. E. Hoover.

The Federal Bureau of Investigation works in close conjunction with the Military and Naval Intelligence Divisions. There has been an enormous increase in its work during recent years, necessitating many additional special agents as well as additional F.B.I. offices. During the five-year period preceding 1938 only 35 National Defence complaints, on an average, were investigated each year. Since September, 1939, complaints of espionage, sabotage, etc., have been received at an average rate of 163 *per day*.

Present War and a future Europe. Part I. By H. M. Cole.

The writer discusses various problems in connection with the present war, and points out how little the belligerents in 1914 were prepared for the course that the World War took.

Since then the problem of air power has become pre-eminent. One question is that of Battleship *v.* Bomber. The battleship has survived, in turn, the torpedo boat and the submarine menace. Up to the present it has survived the bomber

menace. It only remains to be seen whether this state of affairs will continue to hold good.

Another question is whether a successful offensive on a decisive scale can be conducted without an overwhelming superiority in the air. The wars in Spain and Poland were too one-sided to furnish a satisfactory reply.

What will be the military and strategic significance of bombing attacks on great European cities and the civilian population? This question can be reversed: Is there any dictatorship in Europe which dares to run the risk of retaliatory bombings?

In the present struggle between Britain and Germany there has been greater emphasis on blockade and counter-blockade than during the last war. If the submarine, the mine and the aeroplane combine without success in a counter-blockade of the British Isles, there will be every chance that Britain will still be a great power ten or fifty years from now.

The problem of attack *versus* defence and the writer's views on the possibilities of turning the Maginot line or the West Wall are, unfortunately, of little interest now.

The Chinese Incident and the American Revolution.

Major Colby makes a comparison between the coastal invasion of the United States by the English between 1777 and 1783 and the coastal invasion of the Chinese Republic by Japan between 1937 and 1939. Geographically, the resemblance is striking, except for the far greater distance of the base in the former case. But it does not necessarily follow that Japan will fail to subdue China, just as much as it would be rash to prophesy a complete Japanese success.

Design of a Protective Wall for ·30 Caliber Ranges. By Lieut. McKim.

A description of a miniature rifle range, in which special arrangements were required for ensuring the safety of houses behind the targets.

Leading Articles. (1) *Our Natural Resources.* The importance is stressed of preserving the natural resources of the United States: *e.g.*, petroleum, fertility of the soil, forests, water, and wild life. (2) *Heroic Finland*; an article in praise of the Finns in the recent war with Russia. (3) *Target Practice for Civilians*: a plea for the construction of rifle ranges and for the training of the civilian population in rifle shooting.

Third Dimension Maps. By Colonel Blee.

A description of different types of relief maps, of their preparation and reproduction, and of their peace-time application.

Between East and West. Problems of contemporary Hungary. By Dr. Koppanyi.

The outcome of the World War brought about a radical alteration in Hungary's position. The Dual Monarchy ceased to exist, and Hungary was reduced to less than one-third of its former size, and its population from twenty-one million to eight million.

Dr. Koppanyi throws some light on Hungary's military problems, her resources, her dependence on foreign markets, and her national aspirations and policies.

Anglo-Military Notes. By Roger Shaw.

A sketch of the English army from the time of the Norman conquest to the present day.

Flood Control Structures as Affected by Coal Mining Practice. By Captain H. T. Miller.

Mining in the anthracite coal region along the Susquehanna River has caused numerous subsidences, which have affected the safety of buildings, as well as of local flood protective structures. It has been found advisable to use earthworks wherever a levee is employed. It is a simple matter to repair an earthen levee that has subsided, whereas the repair of masonry structures in such circumstances presents great difficulties.

National Rivers and Harbours Congress, March 13–14, 1940.

The principal subjects under discussion at the Annual Convention, held at

Washington on the 13th–14th March of this year, were: National defence, the future of river and harbour and flood control projects, and proposed transportation legislation. The co-operation of the Corps of Engineers with the Bureau of Reclamation was considered very important.

(*July–August*, 1940.)—*Safeguarding the Western Hemisphere*. By Brig.-General G. V. Strong.

The American continent is safe against aggression from abroad as long as two conditions are maintained:—

1. That the Panama Canal is open for the transit of the United States Fleet.
2. That an aggressor from abroad has no bases in the Western Hemisphere from which he can operate.

It is generally accepted that the Panama Canal is safe from an attack by surface vessels alone. But a combination of land, sea and air attacks might succeed in putting the canal out of action. The greatest danger, however, lies in the possibilities of sabotage.

The present canal consists of three double sets of locks. As the lock chambers of each set are side by side, a large bomb in one lock chamber might put the canal out of commission. To avoid this danger, the construction of an additional set of locks has been authorized, separated from the present locks by a distance of a quarter to a half-mile.

Bases from which an enemy might operate are enumerated. They include the Bahamas, the West Indian Islands and islands in the Pacific. Stress is laid on the importance of speed in bringing up a force in an emergency.

Transportation. Its Use and Misuse in Peace and War. By M. J. Gormley.

Experience in the last war showed up a number of mistakes made in railway transport. One important lesson that was learnt is to avoid traffic congestion by preventing the accumulation of loaded wagons beyond the ability of receivers to unload promptly. Statistics show the vast improvements effected between 1918 and 1929. In 1929, with approximately 60,000 less wagons and 5,000 less locomotives than were owned in 1918, 8,000,000 additional goods wagons were loaded.

Possible Results of the European War. By J. G. McDonald.

Without laying claim to be a prophet, the writer indulges in speculations as to what actions Italy and Russia may take in the present war. Both present enigmas. The same is the case with Japan. The U.S.A. is a spectator, but no one can tell how long it will retain that position.

With regard to the result of the war, a German victory would profoundly affect the position of the United States. There are the further possibilities of a stalemate or of an Allied victory. In the latter case, Germany would probably be dismembered.

Maritime Preparedness. By L. S. Baier.

The writer, who had some experience in ship construction in the last war, is able to point out some of the shortcomings of the American war-time shipyard. The most vital was the acute shortage of trained personnel. Next was the haste in designing vessels, which cost the nation a vast sum. Steel ships were built of obsolete types; wooden vessels were designed too small for their requirements and were constructed of green wood. Everything was done with a rush.

Matters are managed very differently now under the control of the War Resources Board.

Strategic Canals. By Lieut. A. D. Starbird.

A dissertation on the value of the Suez Canal to Britain, the Panama Canal to the U.S.A. and the Kiel Canal to Germany.

The defence of the Suez Canal against attack is a simple matter in comparison with that of the Panama Canal, with its vulnerable locks and dams. Financially, the Suez Canal has been a great success, whereas the Panama Canal was built for the promotion of trade, and not for large profits. The present attitude of Italy will seriously affect the earnings of the Suez Canal.

The Kiel Canal has great strategic value for Germany, but was never intended to pay financially.

Atmospheric Pollution and Health. By D. M. Vail.

A plea for controlling the discharge of noxious gases into the atmosphere.

Present War and a Future Europe. Part II. By H. M. Cole.

In this second article the writer shows the advantages that "totalitarianism" possesses in war. These are (1) the belief that war can be made to pay, (2) that it can be carried out without any scruples with regard to humanitarian considerations, (3) that totalitarianism is able to initiate warfare and choose the time and place for attack, (4) the union of civil and military classes, even in times of peace.

Mr. Cole speculates on the kind of peace settlement that will follow the war, and its possible effect on the U.S.A. The decline and fall of European civilization may be a result of the war, and it is for such a future that the United States should prepare.

An Experimental Cement-Soil Levee Road. By Lieut. L. B. Wilby.

A description of an experimental type of road constructed on the top of a levee. Levees are usually constructed of earthwork loosely thrown together, that takes a very long time to become properly consolidated.

The actual operations involve the following: the levee for the proposed roadway must be shaped to the grade and cross-section required; then the roadway is scarified to a depth of 5½ in. by the use of disc harrows or cultivators. Processing starts with the spreading of cement, its incorporation into the soil as a dry mix by the use of harrows and a blade machine, the uniform addition of the proper quantity of water and the incorporation of the latter into the mixture. After just sufficient water has been added, the mixture is consolidated with sheepsfoot rollers until a mulch of about 1 in. remains uncompacted near the surface. This final mulch is consolidated with rollers, and the roadway is covered with straw or loose earth to prevent the loss of moisture for a curing period of about a week.

This type of road might be suitable for military roads where the traffic is not heavy.

In the leading articles the following subjects are discussed: *Preparation for warfare. The strengthening of the Civil Service. Informing the public on what is being done to keep the fighting services up to date.*

Geographic Service in the French Armies during the War, 1914–1918. By General G. Perrier (French Army, retired).

A description of the activities of the French Geographic Service in the World War, and of its co-operation with the Allies.

The Engineers of the IV Corps. By Major C. L. Adcock.

A description of the Engineer operations carried out in the IV Corps manœuvres in Georgia in April, 1940. The work consisted of the erection of pontoon and foot bridges, water supply, and the laying out of defensive positions.

The R.O.T.C.—Key-stone of Emergency Leadership.

Captain E. Y. Blewett stresses the value of the Reserve Officers' Training Corps in the national defence structure. Members of the R.O.T.C. receive their commissions at the end of the fourth year of their students' course. The objective strength of the Corps is 120,000 officers, but this figure has not yet been reached. It is estimated that 120,000 officers will be needed for the citizen army in war-time, and that four out of every five officers required in the land forces must come from civil life.

A.S.H.

THE INDIAN FORESTER.

(*April*, 1940.)—One is sorry to learn that the draft grazing rules for the Bombay Presidency have been withdrawn by Government owing to lack of popular support (see the July, 1939, number of *The Indian Forester* and the review on page 598 of the December, 1939, issue of *The R.E. Journal*). A fresh set of rules is to be put up as a *ballon d'essai*.

Strength tests of *Grewia Elastica* (*siyal phursa*, also known as *Grewia vestita*) give it as great a strength as teak, slightly greater stiffness, and a very much greater ability to resist shock and resistance to shear. The only quality in which it falls far below teak is in retention of shape. Its weight is slightly greater.

A Battle Royal describes a fight between two tigers and an elephant. The former won.

In *Bein River Protection* we read of an evergreen shrub, *Ipomoea carnea* which, it is claimed, forms excellent cover for banks liable to erosion. It is planted in the form of fascines and grows rapidly, forming a dense mass of foliage. It is said to be eschewed by goats, cattle and camels, and to be immune to insect and fungus attacks. There is no end to its useful qualities, for it will prevent wash-outs on roads, serve as pitching on approaches to bridges, guard river embankments and make reclaimed land on riversides permanent.

In the review of the Andaman forest department report we again read of the activities of the Jarawas, a tribe still in the bow and arrow stage of warfare, who during 1938–39 killed four forest and other officials. Punitive measures are in the hands of the police.

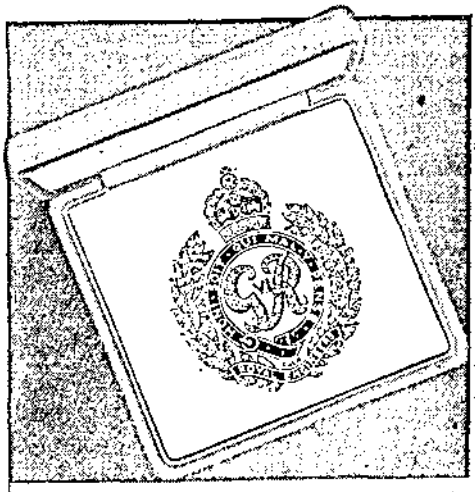
(*May*, 1940.)—Nothing of particular interest to us.

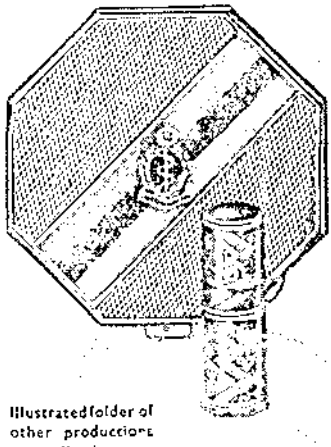
(*June*, 1940.)—In Behar, some 7,500 square miles of forest are privately owned, while only 200 square miles are Government owned. In the former, reckless exploitation was fast leading to destruction and soil erosion, and Government has now stepped in and devised a scheme of 45-year leases of private forest.

Former editions of *Military Engineering* stated that bamboo was a material worth studying. This is well illustrated by a catalogue of uses in an article, *Kampur and Bindraban Bamboo Forests*. Best quality is used for ladder poles, tent poles, tonga-posts, beds and cart sides. Other qualities and smaller sizes for thatching and roofing, ladder rungs, clubs, lance staves, tool handles, flag poles, mosquito-net poles, walking-sticks, cartmen's sticks for driving cattle, *chiqs*, basket-making, kites, bows and arrows, sweepers' brooms, furniture, tent pegs, fences, yokes, axles, mats, pipes, umbrella handles, toys and scaffolding. Another important use is for cellulose for paper-making, while parts of the immature plant can be pickled or eaten as a green vegetable.

An extract from an American paper envisages the use of parachutists for fighting forest fires. They are to be dropped near the site of a fire, and, being self-supporting for three or four days as regards rations, can get to work and put out the conflagration.

F.C.M.





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