There is still another aspect of this combination to be considered: put the fire under the boilers of your ships and steam engines, or in the cylinders of your internal combustion engines and combine it with the vast mass of men and material that modern war requires, and you will have a series of the most interesting problems of movement that it is possible to produce. This is the aspect of the problem that we now have to consider, for an understanding of the principles upon which it is based is of vital importance for the successful conduct of modern war. Whenever these principles are overlooked or neglected trouble arises. The report of the Commission which enquired into the Mesopotamian campaign gives ample proof of this. But it was the same in other theatres—a great deal of our troubles in the later stages of the Great War in France were due to neglect of these principles in the early stages of 1914, and in many cases we never, in the whole course of the war, got over the difficulties we had created for ourselves at the beginning by neglect of first principles of transportation.

Movement is no longer represented by mere muscular power on the field of battle. Machine power is replacing muscular power, and every day the problems involved become more interesting. Military history teaches us the necessity for studying the problems involved. In the Franco-German War of 1870, even in the 1866 campaign against Austria, the use of railways by the Prussians played a very important part in their military plans, while in the Russo-Japanese War, and in the South African War railways became a vital necessity for the maintenance of the forces in the field. No force can go to war from this country without the use of movement by sea; roads, too, play an enormously important part in all military operations. The historical methods of movement by means of railways and roads remain with us, and cross-country mechanical movement must now be superimposed on our strategical conceptions.

There are two outstanding lessons of military history in connection with movement. They are :—

(*a*) That modern operations are dependent on railways or on some approximate equivalent to railways where they do not exist.

(*b*) That a form of military control is necessary over such railways.

With the exception of the Trans-Siberian Railway in the Russo-Japanese War, when strain was felt, railways, prior to the Great War, were capable of carrying out military demands without undue strain. Even so military control was found to be necessary ; it is more than ever necessary to-day. In consequence we have in our Service a Transportation Directorate which functions, generally speaking, from ship side to railhead in an overseas theatre, whereas the actual chain of movement stretches from the Home Country to the front line, and includes sea, rail, inland water, and road transport of all natures, or any combination of them, or in any order.

This whole chain is a Q.M.G. Service, the responsibility being divided between the Q.M.G. at the War Office as far as the overseas base port, and the Q.M.G. in the field from base port to front line. In the field all movement agencies from ship side to railhead are controlled by the Director-General of Transportation under the Q.M.G., in front of railhead they are controlled by formation commanders concerned.

To get the correct picture we should regard movement of anything, man or material, as one whole and continuous operation from its beginning, say, in England to its final destination in the front line ; we should go farther than that, and regard the return movement of the ship, train, barge, lorry or wagon which has carried the article in question, as part of the same continuous and unbroken chain of movement from start to finish. The reason for this is that the most efficient use of a movement system is when it is running

full, regularly, and at the greatest speed of which it is capable.

The underlying principle, which applies to every link in the movement chain, is *quick "turn-round"*; that is, quick loading, rapid dispatch, swift unloading, and prompt return for the next load.

In our Army, as stated above, movement is a Q.M.G. Service; that is, its control is primarily vested in the Quartermaster-General. In other armies it is dealt with by a separate branch. The point to remember, however, is that movement is intimately bound up in every military problem in one form or another. Its problems cannot be confined to one branch of the Staff alone. Even before the war starts, when plans of campaign are being prepared, you must consider such questions as the following:—

(*a*) What are the transportation facilities of the theatre of war, and are we equipped to use them? Consider, for example, what differences would be necessary in our organization for a war in China, in Iraq, on the North-West Frontier of India, in Egypt or in Western Europe.

(*b*) Are there suitable ports for use as a base for personnel and matériel? Has our expeditionary force got to land at a fully equipped port like Southampton or Havre, or has it got to get ashore on an open beach at Gallipoli, or at an ill-equipped port such as Basra was at the beginning of the Great War?

(*c*) What railways exist and what rolling stock? Must we ship railway rolling stock overseas as we did between 1914 and 1918?

(*d*) What inland waterways are there? Shall we take the Thames' steamers and barges with us to maintain our lines of communication on a Tigris or a Nile?

(*e*) What roads are there, and what class of road transport can be used on them? Shall we require heavy lorries, or light six-wheelers, or must we use pack mules, camels, or porters?

All these must be taken into account when making our plan of campaign.

Go one step farther than the plan of campaign and it will be found that, from an administrative point of view, the organization of the base area is primarily one of movement. It is impossible for Staff or Services concerned in base organization to get a correct view of the problem unless they realize the very important part played by movement in its solution.

Thousands of tons of stores arriving at the base ports have got to be moved through these ports and delivered to the fighting man; this is in addition to the movement of the actual troops and their transport.

The next point to bear in mind in connection with movement is that the various agencies concerned in it, railways, shipping, docks, inland water transport, and so on, are really very delicate machines. They require highly technical and skilled management to get the full output from them. With unskilled handling the capacity of a railway, for example, falls off enormously, and if certain technical considerations are not given sufficient attention, you may quite easily break down the system or reduce it to impotence by hopeless congestion.

The existing peace-time technical organization may not be available in war, and a modern army must therefore include the technical personnel for the proper working of its movement organizations. While the soldier, who has to use these various means of movement, must appreciate the importance of technical considerations and make due allowance for them.

In China it has been a common occurrence for a railway line to be completely blocked by the mass of troop trains that have been run over it. The railway

staffs have been helpless, as the military commanders have insisted on trains being run quite regardless of traffic regulations. Trains were dispatched with utter disregard of there being room for them in sidings or not. They were often left standing on the main line itself, while the engines broke down owing to their being kept continually under steam. We are not likely to imitate the Chinese, but if we neglect the principles of transportation we shall certainly produce congestion and delay in our movement systems if not breakdown.

In consequence our army in the field is now provided with the necessary technical machinery in the form of transportation units of various sorts for working railways, docks, inland water transport, etc., and these units are just as essential to a modern army as tanks, aeroplanes or machine guns. In war, however, we cannot leave the entire running of our transportation agencies in the hands of the technical experts. The administrative transportation agency is the servant of tactics and strategy. The fighting soldier is not required to be a technical expert, but he must be in a position to appreciate the technical point of view, and know how best to use the technical knowledge and skill of the expert. It is here that the staff officer concerned with movement must play his part. Let us take an example to illustrate this point more fully :—

The Transportation Service will produce, say, a railhead scheme, their plans will be actuated mainly by technical considerations. The responsibility for acceptance or amendment of the scheme lies with the Staff. The Staff having a broader view than the service of transportation alone, must take into consideration other factors such, for example, as :—

(*a*) Are the railheads well situated from an air defence point of view ?

(*b*) Are they sufficiently far back to be reasonably safe from enemy ground action—*e.g.*, tank, armoured car or cavalry raid. If a break-through occurred, would it be reasonable to

hope for re-establishment of the front, or re-stabilization, before railheads have to be abandoned ? Because it is dangerous to have to change any railhead in the course of an action.

(*c*) Are they far enough forward to allow for secure supply if we advance ?

(*d*) Do the railheads selected demand so much engineer work (railway construction, road and yard making, etc.) that the Transportation or Works Service will be overburdened and have to be relieved from other important work ?

(*e*) Their situation affects the road traffic problem. Are the locations suitable from this point of view ?

These and similar problems will have to be decided by the Staff in consultation with the services concerned. Only railways have been mentioned, but it is the same with docks, inland water transport or any other transportation agency and the Staff must know about these questions to enable them to compete successfully with their share of the problem.

Thus we arrive at a double-branched system for the control and operation of transportation in the field : the staff side and the technical side, the whole being controlled by the Q.M.G., who has a D.Q.M.G.(M.) to assist him in this branch of his responsibilities.

The staff side is represented by staff officers of every grade down to Staff-Lieutenant, better known to fame as the R.T.O., while the technical side is represented by the directors of railways, light railways, inland water transport and docks with their various assistants, and there is also a close association with the Director of Works in all matters pertaining to constructional engineering work for roads, docks, and piers and suchlike necessities of movement, other than railways.

With the technical side we need not concern ourselves

further at the moment, but we will consider the staff officer's task in greater detail.

For smooth and efficient working we first of all want regularity—regularity of demand producing regularity of output. Any variation must tend to upset the normal working of the system. In war, however, variation cannot be avoided. It is by variation that the commander hopes to obtain surprise. Some contemplated operation causes an abnormal demand for the time being, action by the enemy may call for sudden and unexpected variation, the weather may interfere with the regularity of oversea communication, frost or floods, snow or thaw, may easily cause serious interruptions upsetting, for the time being, the carrying capacity of one or more links in our transportation chain.

In war variation is always occurring, and it is the enemy of efficient working. The duty of the Movement Staff is to compete with this difficulty to foresee the sudden changes and to be prepared to meet them—foresight, ingenuity, improvisation and unremitting energy are required from all officers of the Movement Staff.

In a small war, possibly also in a great, phases of active operations imposing abnormal demands on the transportation service are likely to be of comparatively short duration. If they can be foreseen well ahead, it should be possible to build up reserves of material sufficient to meet abnormal requirements, and so avoid fluctuation in the demand for special categories of stores from the base. Cases will nevertheless occur when unforeseen strain will be imposed on the transport services, and it will then become the duty of the Staff to decide on a priority of dispatch of material.

Movement as a whole is controlled by the Staff, but this control is an elastic one ; at times rigid and amounting to " command " ; at others, intangible almost as in traffic control of road transport, or the routing of individual ships at sea.

Sea transport and road transport are by nature

extremely flexible; railways and inland water transport are exactly the reverse. The less flexible the means of transportation, the tighter and more rigid must be the control. You cannot allow any "monkeying" with a railway system to meet the wishes, or even prayers, of individuals, because it goes against every principle of sound operation and sooner or later brings about congestion and breakdown. Here, then, you have the maximum of rigidity and the maximum of centralized control. For the individual ship at sea, or lorry on the road, it may often happen that, within limits, one way is as good as another. Much can be left to the ship's captain or the lorry driver; the system is flexible, the control elastic.

To get the best results we want to ensure a steady, well-balanced flow of commodities through each link in our chain of movement, no one link being overloaded. The reinforcement of one echelon in the chain of supply may throw an undue strain on the next; reinforcement at one stage calls for a corresponding reinforcement in the other links. The Staff must always be watching for any factor tending to upset the balance and in conjunction with their technical advisers must take steps to put the trouble right.

The most probable places for trouble to arise are at the points of contact of the various transport agencies, such as docks, loading points, railheads, refilling points or transfer points. Here, with two or more agencies meeting, you may get conflict of interests and possible interference with operation. Interference may be caused by enemy action, bombing or artillery fire, or it may be due to bad staff work, such as failure to provide sufficient labour, neglect of traffic control, or lack of appreciation of the evil results likely to arise from a certain course of action. The Staff must put the matter right, and they must put it right quickly, or the trouble may easily get out of hand.

Pressure will often be exercised to obtain a relaxation of rules which are based on sound movement principles.

Such pressure may be exerted by individuals who seek to alter timings to meet their particular requirements, or who ask for special consideration to facilitate the working of their own service. For instance, there may be pressure to relax the sound rule which forbids the formation of depots in dock areas or further forward in railway station yards. The Staff must consider each case on its merits, in conjunction with the advice of the experts, making due allowance of course for the possibly one-sided outlook of the technical expert, and decide what is to be done. But do not give way on a question of principle unless you are faced with an emergency the gravity of which justifies the serious consequences which are likely to arise.

The policy as regards movement must be dictated by the operational requirements necessary to give effect to the commander's plan. It will, however, sometimes happen that operational requirements are at variance with working on sound movement principles. For example, the piling up of fighting formations as reinforcements in Mesopotamia, when the available transport was already inadequate to maintain the troops which were there, only added to the difficulties of the situation, and made the relief of Kut all the more impossible. In such cases it is the duty of the Movement Staff to point out the effect on movement likely to result from the proposed operational policy. If adjustment cannot be effected in consultation between the branches of the Staff concerned, appeal to the commander is the only solution, but with a good Staff this should rarely if ever be necessary.

This possible difficulty might be overcome by making Movements a branch of General Staff work instead of a " Q " responsibility, but as the things which put the greatest strain on movement facilities (things such as supplies, ammunition and maintenance stores) are matters which are the special province of the Q.M.G.'s department, it seems more logical for movement control to be vested in " Q."

The necessity for regarding movement as a whole from start to finish, for the complete turn-round of the modes of conveyance, has already been referred to. For smooth working, and in order to avoid congestion at any stage, continuity and regularity of movement are essential; to obtain this, centralized control is a *sine qua non.* In consequence the Movement Staff must be part of the G.H.Q. Staff, and this is the organization in our army.

With these preliminaries the principles which are applicable to any transportation system may now be summarized as follows :—

(*a*) The capacity of the whole system should be approximately the same from end to end.

(*b*) The facilities at the terminal points and transfer points, such, for example, as docks or railheads, should be sufficient to ensure a rapid turn-round of the carrying vehicle.

(*c*) The means of transport should be kept continually in motion and loaded to their full economical capacity.

(*d*) Movements should be balanced in both directions.

These principles may sound academic, but a few moments thought on their application to particular cases will show their truth.

Imagine, for example, ships continuing to discharge in a dock more rapidly than rail, road or other transportation agencies can remove the goods, and it is clear your dock will soon be so congested that further unloading of ships would become impossible. Or again, if forward movements are not balanced by movements in the opposite direction, you would soon find all your available railway wagons, or lorries, or other means of conveyance collected at one end of the line while none was available for reloading at the starting point. This appears obvious in print, but the principle was in fact often neglected during the Great War with results

tending, had not drastic steps been taken, in the direction indicated.

Section 2. Technical Organization for Movement.

In the previous section the general system for the organization of movement into a staff side and a technical side has been outlined. The *raison d'être* and functions of the technical side will now be considered in further detail.

In most theatres where war is possible, and certainly in Europe, we shall have to develop and employ every means of transportation possible. We shall have railways, light railways, docks, roads and inland water transport. Each of these has its own special technical characteristics as regards survey, construction, maintenance and operation. Each again employs its own types of skilled tradesmen of innumerable grades for construction, operation, mechanical engineering, conservancy, buoyage, pilotage, marine engineering, and so on. Though all the various means of transportation in war will be working to the same end, namely to deliver the goods to the fighting man, they work each under their own technical head, and to get the best value from our transportation system as a whole we must have a co-ordinating technical authority.

It might be asked, why cannot this co-ordination be done by the Movement Staff under general direction of the Q.M.G. ? The Staff is responsible for the general movement policy, could they not also ensure that each transportation agency works technically in close co-operation with the rest of the group ? This plan would not be a sound one, because the questions involved are frequently of a highly technical character, and although technical knowledge is most desirable in the staff officer, in the nature of things it cannot normally be great or sufficiently widespread. The necessity for a co-ordinating technical authority, will perhaps, be made clearer by considering some cases in which such an authority would be required to act in practice.

Take first a case where two services meet and competition arises for the use of some plant common to both. Such a case occurs in connection with a railway service inside a dock area, the operation of which must closely affect the Docks Directorate on the one hand, and the Railway Directorate proper outside the dock area on the other; similarly, lighter work inside the dock area affects both Docks Directorate and Inland Water Transport Directorate. Or again, the operation of a swing bridge or similar installation which, when shut, blocks say the inland water transport, but allows railway or road traffic to proceed, and which, when open allows inland water transport traffic and blocks railway or roads. Even level crossings on important traffic routes may require special treatment.

Questions such as those just mentioned of traffic movement inside docks, or the hours of opening of swing bridges, are more likely to be technical questions, depending on factors such as railway timings and tides, than to be questions of general movement policy and they are therefore better left in the hands of the co-ordinating technical authority.

At times, however, questions of policy may arise as when tactical considerations require a bridge to be kept open for the passage of troops—in such cases it is clearly the province of the Staff to impose a decision which must be accepted by the transportation authority.

Another type of case may arise wherein there is a conflict of interests calling for decision by the technical authority. For instance, after an enemy's bombing attack, urgent demands from two services might be received simultaneously for specialized lifting gear to deal with separate breakdowns. The Director of Transportation has then to decide which is the more important to clear first, and he allocates plant accordingly. Take another case. Suppose coal supplies are temporarily restricted from any cause. Which service is to have its demands most nearly met? Coal for tugs—*i.e.*, the inland water transport directorate;

coal for railway engines—*i.e.*, the railway directorate; or coal for steam cranes—*i.e.*, the docks directorate. How much of the whole transportation allotment is to go to each? Will it be more economical temporarily to reduce railway traffic and increase inland water transport? These are all technical points, and they require decisions from a technical authority rather than from the Staff.

Yet another occasion for the exercise of the co-ordinating authority of the technical head arises from the variation of the army's demands from time to time on the service of transportation. During quiet periods, apart from the duty of building up reserves, one must try to withdraw into technical reserve as much as possible of the technical plant and personnel, so as to be ready for the big effort which is certain to be demanded later. Who can decide what goes into reserve? Clearly not the head of any one service, for it is only human nature to conserve one's own show against the day of need at the expense of the other man's. These are points of *technical* policy to be decided by the *technical* head—the Director of Transportation.

It is inadvisable to take one of the directors—say, of railways—and make him also the co-ordinating authority for the lot, because with all possible goodwill he cannot fail to look at the problems of the other branches otherwise than through the tinted spectacles of his own particular line of business; and with the financial responsibility, which such a position carries under our existing regulations, any one man would be unduly burdened in undertaking the dual role. Consequently in our existing War Establishments a Transportation Directorate is allowed for, with a Director of Transportation at its head, or, if large forces are concerned, we have a Director-General of Transportation.

It is hoped that the relative functions of the two distinct sides of movement organization—the staff side

and the technical side—have now been made clear. It is very necessary for soldiers to appreciate this organization correctly, because when our army expands to a war footing, the officers who will fill these technical posts will be drawn to some extent from civilian sources; though they will be great experts in their own line of business, their military knowledge may be limited. It is therefore necessary for the soldier to have sufficient knowledge of the technicalities involved so that, while not attempting to force impossible demands on the technical service, he may not be imposed on by the highly coloured representations of the technical expert.

Section 3. Application of the Principles of Movement.

Having considered the main principles upon which our war-time movement organization is based, we will pass now to the application of those principles to the lines of communication of an army in the field, taking the case of an army operating overseas and receiving all its needs, whether personnel or matériel, through one or more base ports.

First of all, let us try to picture to ourselves what the term "lines of communication" really means. One sees, I think, ships on the sea converging on a point, a base port, thence a railway or river leading into the interior, and then a road going forward from rail or river head, eventually reaching the soldiers in the front line; the whole conception is linear. Do not forget, however, that it is not the line of Euclid, which, as will be remembered, has length without breadth, for our lines of communication have considerable breadth; they are areas, not lines. This is the first point to get hold of—that the L. of C. is an area, which has to be divided by its commander into sub-areas in accordance with the various activities carried on in different parts of it.

Thus, if we imagine a L. of C. starting at Southampton and running to London, we might have a Southampton Dock sub-area—an Eastleigh Base depot

area—a Netley Hospital sub-area—a Hindhead Convalescent sub-area—a Farnborough R.A.F. sub-area, and so on according to our requirements; and our movement system would be intimately connected with all this organization. The whole conception of our lines of communication must be one of movement.

The next mental picture to get hold of is the enormous amount of movement that is continually going on in the L. of C. area. In addition to train-loads of ammunition, the daily supply pack trains, ambulance trains, and leave trains, there will be train-loads of bulk stores, such as timber, R.E. material, road stone, coal and similar commodities, trains of remounts or of sick horses going to and from the front. For everything that goes forward there should be a corresponding movement towards the rear. Then again there is continual cross movement between depots, regulating stations, and railheads, and from hospitals, and remount depots to convalescent depots for men and animals. Superimposed upon this you may have considerable strategical movement of troops. Then there are reinforcements to go forward, damaged guns and stores to come back for repair and their replacements to go up to the front. You cannot live from hand to mouth; in addition to your daily requirements, you must build up reserves behind your fighting formations as they advance. This all means movement. All will have read of the wonderful development by the Germans before the war of their strategical railway system. They started the war with sixteen railway tracks across the Rhine; they ended it with twenty-six, an increase of sixty-two per cent., which was still barely adequate to meet their maintenance requirements.

All this sort of thing is quite obvious when one stops to think about it, but its application in war is very apt to be overlooked. When plans are being made to launch armies into the heart of China, Russia, Iraq or Afghanistan, this movement picture must be kept in mind, or these same armies will starve at the ends of

precarious single lines of railway, or they will be compelled to surrender to the enemy as in the case of Kut.

Having painted the general picture, let us now consider how the mass of men and matériel arriving at our overseas base ports is dealt with there and subsequently sent forward to the front.

The case of an opposed landing, which is a tactical operation, is not under consideration in this case, but a landing in our own territory or in the country of an ally, which is not liable to be interfered with by any action of the enemy's ground forces, though the possibility of attack from the air cannot be left out of consideration.

Movement of Personnel.

The manner of dealing with troops when landing overseas and moving to a concentration area is normally as follows :—

(i) All troops will move from landing quay into reception camps by march route.

(ii) Troops remain in the reception camps from twelve to twenty-four hours for purposes of :
  (*a*) Medical services ;
  (*b*) Separating out details to remain at the base, such as first reinforcements ;
  (*c*) Completing any deficiencies in equipment.

(iii) Troops are moved to the concentration area normally by rail, but possibly by march route.

That is, in brief outline, the normal method of dealing with personnel. The methods of moving troops by rail in strategical or tactical trains will be dealt with in a later chapter. We will now consider the methods of dealing with stores and material of all kinds.

Movement of Stores.

Our ship-loads of material arrive in the docks and here they are dealt with in one of two ways :—

(*a*) *Normally* by transportation service alone direct from ship side to base depot, thence by "pack" or "bulk" train to railhead by mutual arrangement between transportation and the service concerned; by service concerned is meant the supply, ordnance or other service.

(*b*) In special circumstances direct from docks to railhead after request by the service concerned.

The movement staff is concerned in case (*a*) only in general supervision; the consignee service is not concerned at all until the goods arrive at base depot. The movement is a transportation routine matter. In case (*b*), which is contrary to certain principles which will be returned to later, justification for the demand is required from the holder to the movement staff. It will be observed that the goods go direct from ship side to base depot, or in special cases to railhead; they do not go into warehouses in the docks area. In this respect the practice of war differs from that of peace. In the Port of London, and in fact in practically any commercial port throughout the world, a very large part of the business consists in warehousing, and from this source the bulk of the revenue of the port authority is derived.

Space in the immediate vicinity of the actual docks is utilized to build warehouses, the floor space in which is let out to merchants, and there they store their goods pending marketing. As the commercial prosperity of the port increases all available space for expansion is taken up and the necessity arises for a new dock elsewhere—thus Bristol throws off an Avonmouth and the Tyne constructs a North and South Shields, mainly because there was insufficient space at the parent port to deal with the increased volume of traffic. This state of affairs comes about slowly in peace time and the majority of ports about the world are quite stationary in this respect and are able to compete with the normal

commercial activities of the areas they serve. But subject any one of these ports to the enormous development necessary for the base port of an army, and it becomes obvious that no warehousing at all is possible in the dock areas, or congestion will at once arise. So you arrive at this *first principle* of military transportation :—

Allow no warehousing—i.e., no depots in the dock area. This is a principle that was very largely neglected when the British Expeditionary Force first landed in France in 1914, and this neglect very nearly caused a breakdown in our maintenance system later in the war; the reason being that in 1914 there was a tendency to utilize space inside the dock areas for warehousing military stores, or in other words, for base depot purposes. This soon caused serious congestion in the ports, and prevented the unloading of subsequent consignments of goods.

We now know that the use of an ordinary commercial port as a military base port will demand such an extension of dock railway facilities that it may even become necessary, if warehouse buildings exist inside the dock area, to pull them down and remove them altogether in order to make room for the necessary railway expansion. This, of course, does not refer to the transit sheds which are an essential link in the clearance facilities of a port, and the worst crime of all is to make a depot in a transit shed.

It should be remembered that no port is ideal for military purposes, and that every commercial port has its own class of trade and its distinctive method of handling it. For military purposes the class of trade may have to be altered. Any alteration in the class of goods to be sent through a port cannot be made until a very careful examination has been carried out of the port facilities to handle such goods, and an appreciation gained of the capabilities of those facilities to deal with goods which the port has probably not been designed to handle. For example, a wheat port fully equipped with suction grain elevators may not be suitable for

landing heavy mechanical transport, and ports which normally handle passenger traffic in the main, are rarely provided with lifting appliances for heavy weights.

In dealing with questions of dock development for military purposes it is important to bear in mind that docks in themselves are not, strictly speaking, a movement agency any more than a refilling point is. They are simply a transit point between two agencies operating on sea and land respectively. The essential of dock working is movement; as fast as goods arrive in the dock they must be removed outside the dock area. Any development of dock capacity must therefore have a corresponding development of the transport agencies—rail, road or inland water transport—to remove the goods arriving in the dock. It is useless to develop a dock beyond the capacity of the removal facilities adjoining it. And this is *another principle* of transportation. *The operation of military docks is for transit and transit only.*

Dock work is dependent on harmonious operation with two other services—sea transport and railways. The problem is to keep the balance right, so that no more and no less is brought into a dock area by either agency than can be handled in transit by the docks service and by the other agency in clearing the dock area.

It was on account of this that it was found necessary in the Great War for all demands, emanating from the army in the field, for the shipment of stores from the Home base to be co-ordinated by one authority. This co-ordinating authority was vested in the man who was in the best position to know what quantities of stores of different natures could be received and handled in the docks on any given date, that is to say, the Director of Docks. The system was accordingly introduced of sending one telegram daily to the Home authorities stating the natures and quantities of the stores, required by each one of the different services, to be shipped overseas for arrival on any particular

date. This telegram—agreed to by the services concerned—was sent by the Director of Docks, and by this means dock congestion and consequent delays were reduced to a minimum.

A similar problem arose at the shipment end where it was found that, unless control was exercised from the docks, goods would arrive in the dock area by rail from the various factories throughout the kingdom in the wrong order for loading in the ships. This gave rise to considerable railway congestion inside the dock area, and seriously delayed the actual loading of ships. So a system was enforced of notifying the port when stores were ready for shipment, the actual stores remaining in the factories until called forward by the Director of Docks. By this means it was found possible to arrange for the stores to arrive alongside the ships in a convenient order for stowing, and this resulted in very much increased speed in the loading and dispatch of goods and a great reduction in the time which ships were required to spend in harbour. It will be observed that this is nothing more than the application of the four principles of movement as summarized at the end of Section 1.

Bearing these principles in mind it will be easier to understand why a system has been adopted which necessitates two separate journeys and handlings for each ton of material landed at a base port. One trip from the dock to the depot and another from the depot to railhead. Why are the stores not sent straight from the docks to railhead? This double system is admittedly costly in labour, but there are material advantages in its adoption as a standard practice.

Whenever any attempt is made to rail direct from quay to railhead you invite the evil of congestion. Once started, the cure is difficult and sometimes almost impossible without stopping down imports to a dangerous degree. Furthermore, the average flow to the troops in war has been proved to be less. This is due to many causes, but perhaps chiefly to the restriction

of elbow room for satisfactory rail working in the dock area.

Whatever the cause, this lesson emerges :—

(*a*) That interference with the free movement of material out of the dock area must be reduced to the minimum.

(*b*) That this reduction is certainly best secured by leaving this movement to the Transportation Service, whose sole interest is rapid movement. This means that the services (supply, ordnance, etc.) should take an active part in handling their material only after its arrival in the depot.

Causes may arise which make it imperative to avoid the delay in and out of depot in respect of certain specific lots of material. When this happens the service concerned must put the case to the Movement Staff, but in practice instructions for such action will always emanate from superior authority at G.H.Q. Examples of this might be a consignment of special fittings for say tanks or aeroplanes, or a special type of ammunition required in connection with some operation contemplated for an early date.

It should be noted that from the point of view of the service concerned there is a great danger of delay in despatch of any direct consignment from dock to railhead if :—

(*a*) The consignment is part of a miscellaneous cargo ; or

(*b*) Is composed of different articles which may perhaps not be loaded in one hold of a certain ship ;

(*c*) It requires any turning over, or sorting, of material already landed on quays or in transit sheds in docks.

Under the normal system there is an additional advantage in that any cargo can come to any port or any berth in that port with the moral certainty that, no

matter how they are loaded, stores collected from any such cargoes for a particular service will arrive at the appropriate depot, where sorting out can be carried on expeditiously, by the service concerned.

This simplifies the loading problem at home, permits homogeneous cargoes of any size to be shipped from any port at home or abroad direct to the base port in the theatre of war, ensures greater safety of valuable cargoes by letting ships get inside harbour, protection more quickly, and results in a general speeding-up of tonnage deliveries.

Take ammunition as an example. The shell may be made in the U.S.A.; the fuze in Birmingham; the cartridge at Waltham Abbey. Ship loads of each individual component might go direct to your overseas base ports. The three components would meet for the first time in the base ammunition depot—there be "married"—and go forward as complete rounds to railhead. It is complete rounds that are needed at railhead. Or again, take supplies. Man cannot live on cheese alone; he wants a complete ration—meat from the Argentine, cheese from Denmark, jam from Australia, tea from India. The component parts of the ration land at the docks in separate loads, they meet in the supply depots. The soldier gets a complete ration, sent forward to him in the supply pack train.

Dock Development.

Before leaving the subject of docks it would be well to consider for a moment the problem with which the soldier may be faced at the beginning of a campaign by way of dock development. It will be readily realized that in order to meet war-time military needs, the average commercial dock will require considerable expansion and development, especially of its railway facilities, before it can serve adequately as the base port for an expeditionary force of any size. The development, during the Great War, of the ports of Kantara and Basra for the service of the forces in Palestine and Mesopotamia respectively are admirable

examples of the development that may be required. These perhaps are extreme cases amounting practically to the construction *de novo* of two first-class ports fully equipped to meet the needs of very considerable forces; the adaptation and improvement of an existing port would not call for quite such elaborate constructional work.

Sketch Diagram No. 1 indicates a type of development that could be installed fairly rapidly to utilize or extend the facilities of a port at the mouth of a river; beyond the transit shed there would be more railway lines which have not been shown in the diagram. From this it will be clear that the placing of the necessary railway trucks in position for loading alongside the ships, hauling them clear when loaded, and replacing them by others, must involve a tremendous amount of shunting and marshalling of trains. Also, while shunting is in progress, the movement of dock labour across the permanent way must be reduced to a minimum or casualties will result.

To get over these difficulties, the railway layout is so arranged with reference to quays, transit sheds and plant, that the shunting work can keep pace with the dock transit loading if certain free periods are arranged during which dock labour ceases. A short period at midday and one long period at night meets the case best, so dock labour is organized in shifts accordingly. It will be possible very rarely to work three shifts in docks in the twenty-four hours. Two eight-hour shifts with a short period between them is the best that can be expected. The actual organization is a matter which should be left to the technical expert, as experience alone can decide the most suitable conditions to meet each particular case.

As regards the output, or dock capacity, that may be expected from a port under war conditions, it has been found from experience that, taking the averages of all army traffic and assuming single-shift working, from 1 ton to 1.2 tons per lineal foot of quay per day represents

good working. An equipment of one wharf crane for every 100 feet of quay (in addition to floating cranes for special purposes) constitutes a satisfactory equipment, and an output of 110 tons per crane per day, single shift, represents good working average for all classes of cargo. For general cargo easily handled the output of a crane rises to 175 tons per day, and with such cargo as grain or flour in sacks 25 tons per hour, or say 250 tons per day per crane, is attainable. For every *hour in port* a ship should discharge from twenty to thirty tons of stores. It is generally most economical to work double shifts of from eight to ten hours a day each, if dock plant facilities are good enough; the remainder of the twenty-four hours being required by railway staffs for adjustments of railway rolling stock, etc.

Stores will normally be handled twice in the dock area—*i.e.*:

From quay to transit shed;
From transit shed to railway wagon.

But when possible load direct from ship to railway wagon. Stores will again be handled twice in the depot—*i.e.*:

From railway wagon to stack;
From stack to railway wagon.

A third handling may be unavoidable in the process of stacking. An average man can handle six tons of stores once per diem.

Section 4. The Organization of an Overseas Base.

It has been explained above how, in normal circumstances, our military stores, on first arriving in the docks overseas, are forwarded thence by the transportation service into the base depots. In the base depots they are taken over by the services concerned and are subsequently distributed along the lines of communication to the troops in the field. Before dealing with the method of the further movement of the stores forward

from the base, it would be as well to consider the system in accordance with which the organization and construction of a base depot is set on foot.

When an expeditionary force goes to make war overseas one of the first things it will want is a port to land at. Possibly it may be compelled, in the first instance, to land on an open beach. The maintenance requirements of a modern army are, however, so vast that a landing on an open beach can only be looked upon as a preliminary to the seizure, or possibly the construction (as in the case of Basra and Kantara during the Great War) of a properly equipped port at which to land its essential military requirements.

If we are lucky enough to find a first-class dock, equipped with up-to-date appliances, our first problem is an easy one, but this will not always be the case; we shall have to make the best of what is available and discover a means of getting over the difficulties presented by each particular case. Probably no port is ideal for military purposes, and having selected the most suitable we shall have to develop and expand it to meet the army's needs.

What factors should guide us in selecting a port at which to land our army, or, if we have to construct a port for ourselves, what are its requirements? The primary requirements of a port, for whatever purpose it is intended, are firstly the means of ingress and egress, if possible at all states of the tide. This means an approach channel, breakwaters, buoys, lighthouses and pilotage arrangements. Next we require places at which ships can lie to load and unload and also to undergo repairs. These places are quays, wharves, sheds, appliances for rapid loading and unloading, and dry docks.

Thirdly, we must have the transportation facilities by rail, road, river or canal, or any combination of them, by means of which the goods can be conveyed from the quays to the distributing centres inland and vice versa.

In war, from one cause or another—enemy action necessitating the convoying of ships, bad weather, or mechanical breakdown—delays to shipping occur with consequent irregular arrivals at the base ports. This overstrains the dock facilities at times and congestion arises in the port. This congestion may easily assume serious proportions, unless ample clearance facilities—generally far in excess of normal requirements—are provided to cope with it. As an example of this the case of Vladivostok during the Great War may be quoted. Two million tons of munitions were landed at Vladivostok, but they never reached the Russian armies for whom they were intended, because the railways were inadequate to clear the port, and a hopeless state of congestion arose in the docks. It follows from the foregoing that we must have within reasonable reach of the port, but clear of the dock area, depots into which we can discharge the excess of goods, without reference to their ultimate destination.

Furthermore, when we are making war overseas, we must have reserves of all the army's needs stored in the theatre of operations. The amount of these reserves depends upon the distance from our ultimate base in the United Kingdom, on the liability to interruption of our communications and on a variety of other considerations that we are not concerned with at the moment. This again gives rise to the necessity for a base depot, the requirements of which, and the method of its organization, will now be examined.

The problem in this connection, which faces the advance party of our expeditionary force, consists primarily in establishing the best possible administrative machine behind the fighting forces before they come to grips with the enemy. The whole of the preliminary arrangements for the organization of the base must be conceived and must be reduced to a clear plan, and the plan must not only consider the expeditionary force which first leaves the home country, but it must envisage what that expeditionary force is going to increase to,

and what the liabilities are going to be at the base in, say, six or eight months or a year.

When one starts on active service any mistake which is made in the initial stages is very difficult to rectify afterwards; consequently the work of the Advance Party is of all the more importance. At the same time, this preliminary work will in practice have to be carried out with the greatest possible speed. The Advance Party will be over at the new base, and everyone at home will be anxiously awaiting their first reports to enable them to complete their own preliminary arrangements for the provision of the various requirements for which they are severally responsible. The conditions may vary from the development of a Southampton, or an Avonmouth, to the complete installation of a port at a place like Basra.

It must also be kept in mind continually, in all problems of base organization, that operational questions must take precedence over questions of pure administration. We have now reached the stage that no base—so long as there are aircraft on the enemy's side—or no portion of the lines of communication, can be considered safe from air attack. If the port of disembarkation is within striking distance of the enemy's air forces, it may be taken for granted that, directly it is known to him that forces are being landed there he will, if possible, attack it heavily from the air, and our defensive arrangements must be organized accordingly.

The eventual expansion of an army operating overseas will normally require the development of at least one port in the theatre of war as a base for the maximum force which can be maintained from that base. The size of this force will depend upon the capacity, existing or capable of development, of the lines of supply radiating from the port.

The preparation of even the rudimentary elements of a layout of this nature will involve extensive constructional operations by the Works and Transportation Services. This will take considerable time, a matter of

months; the landing of the expeditionary force cannot, however, be delayed until the base is built. In the meantime such forces as are landed have got to be maintained in all their fighting and administrative necessities, but the landing of the force and its maintenance when landed should not be allowed to interfere with the constructional development of the base area.

In principle, therefore, the best plan is to land the original force at one port and maintain it through the same port, while developing another port as the permanent base. When the permanent base is ready, transfer the maintenance of the force to its permanent home. This, however, will often not be a possible plan, and we may be compelled to use one port only and so organize our temporary maintenance arrangements as to interfere as little as possible with the development of our permanent organization.

The problem at a port like Southampton would be an easy one; the problem at Basra was very much the reverse. Throughout the three volumes of the official history of the Mesopotamian Campaign there are references to the difficulties arising from the deficiencies of Basra as a base port. The development which was eventually carried out there was colossal and forms a most interesting study. In Vol. III, pp. 255–257, there is a short description of how Basra grew from nothing to a great port extending over many square miles.

Our problem of base organization can now be summarized as follows:—

(i) To make a plan for the development of the port or ports selected.

(ii) To make a plan for the temporary maintenance of the force.

(iii) To make a plan for the permanent maintenance of our ultimate force.

Having stated the nature of the problem, we will now consider how it is tackled.

The advance party, whose duty it is to prepare the

plan, would consist of the officer appointed to command, pending the arrival of the C.-in-C., and such staff officers from G.H.Q. 1st Echelon as the C.-in-C. may direct. The party would also include the Directors of all the services or their representatives, the Base Commandant and the G.O.C. L. of C. Area, representatives of the Air Defence Commander and the Air Officer Commanding, of the Admiralty and the Board of Trade, with assistants and office establishments as necessary. This party, together with the necessary L. of C. administrative units, air defence troops, and such covering force as might be required by the circumstances, would proceed overseas in advance of the main forces.

It is obvious that the party outlined above would be of considerable size, and it is most desirable in consequence that it should itself be preceded to the overseas base by a small reconnaissance party, consisting of certain staff officers and representatives of services, to make the preliminary arrangements required before any troops arrive at all. It is the work of this small reconnaissance party, which we will call the staff of the advance party, which will now be considered. Their procedure would be as follows :—

(i) Immediately on landing—or before if maps and intelligence are considered sufficiently reliable—the Staff of the advanced party hold a conference, calling in the Base Commandant and senior Transportation Officer. A preliminary plan (1st Key Plan) of organization is prepared by the D.Q.M.G. (M.) as the joint work of this conference, under which each service is allocated tentatively the sites it requires.

(ii) Heads of services are now called into the conference and the D.Q.M.G. (M.) explains the general idea of his proposals—*i.e.*, he lays down a tentative administrative policy and the general arrangements proposed for each particular service. This constitutes

the 1st Maintenance Project (*i.e.*, the first issue of administrative instructions of which the 1st Key Plan is the map).

(iii) On termination of this conference, or on landing at the overseas port, the heads of the services arrange to reconnoitre the proposed sites, and, with the assistance of a transportation officer, prepare a scheme for the utilization of these sites.

(iv) At a prearranged time a second general conference is held, the D.Q.M.G.(M.) presiding. At this conference all services in turn represent verbally the views they have arrived at as a result of ground reconnaissance, and the staff, considering their views, gives immediate decisions on conflicting claims or any other difficulty that may have arisen.

(v) On termination of this conference the staff should be in a position to draw up the 2nd Key Plan of organization and to issue the 2nd Maintenance Project; while the services can complete in detail all work in connection with the layout of their various installations. If difficulties have arisen further discussion on the ground may be necessary with the staff present to give decisions.

Throughout the whole of these preliminary arrangements, the officer appointed to command, pending the arrival of the C.-in-C., must be kept in touch with the proceedings, and his agreement to the final plan must be obtained having due regard to the operational aspect of the question and the problem of A.A. defence.

Some Difficulties and how to tackle them.

The organization of the base area is primarily one of movement. The base port should be regarded purely as a transit area. All material landing with and

immediately following an expeditionary force being sent forward to a temporary depot either in the troop concentration area or in the close neighbourhood of the port. Simultaneously the organization of the permanent base area should be set on foot, and it is necessary to ensure that the temporary maintenance arrangements are such as not to interfere with the development of the permanent organization.

First, lay out the dock area. This will become a reserve transportation area, and in it there must be no storage other than depots mostly of a very temporary nature connected with the development and maintenance of the port itself.

Next, decide on the locality of depots, their size, and transportation conditions.

The layout of the depots themselves is a technical matter for the services concerned in consultation with the Transportation Directorate. The staff must, however, be prepared to advise in connection with the co-ordination of movement generally, to decide in cases of conflicting interests, and to watch the situation with regard to air defence.

The guiding principle in selecting depot sites is to allow for the maximum expansion possible, consistent with the capacity of the actual port when fully developed and eventual possible expansion of the field army. It is far better to err on the large side than otherwise, and at the beginning of a campaign a wise precaution would be to double whatever area was considered necessary in the first instance.

The difficulty of siting the various base depots is to reconcile the conflicting claims of administrative convenience and tactical necessity as represented by the problem of defence against air attack. In consequence of this it will generally be necessary to locate base depots for personnel and animals a considerable distance from the actual docks, even if this involves marches up to five or six miles. As regards the stores depots of the various services, there are

certain rigid factors which will nearly always operate against any wide dispersion of them, however urgent the tactical necessity for such dispersion may be.

The chief reason for this is that *flat ground* is an absolute necessity where any large layout of railway sidings is needed. In modern war the quantity and bulk of stores is so great that large store depots must be railway fed. This involves a network of sidings adjoining the depots, where strings of trucks can stand while waiting to be loaded or after loading. Such sidings cannot be on an incline and the time and labour involved in levelling any large area of undulating ground would usually be prohibitive. Hence it follows that the railways must be given first claim on any flat ground available and they must make the best of it wherever situated. If the total area of flat ground is small, as will often be the case, the base depots for stores which must necessarily cluster round this flat area, may often be dangerously close together.

The remedy appears to be :—

(i) In the provision of adequate A.A. defence.

(ii) In not attempting to supply too large a force from one set of depots—*i.e.*, several baskets for the eggs instead of one.

(iii) In so planning the individual depots in one area that a bad shot at one would not hit its next door neighbour.

Yet another important consideration to bear in mind when siting our base depots is to locate them so as to reduce the dead mileage of railway wagons to a minimum, and to avoid all unnecessary counter-marching of stores as between port and depot, and depot and regulating station or railhead.

The following diagrams show the normal type of layout to be adopted in constructing base depots. Plate A shows a supply depot, Plate B an ordnance depot, and Plate C an ammunition depot. In each of these plates Fig. 1 shows the regular layout which would

be ideal from the operating standpoint, but one which would only be obtainable in comparatively open and level country. The other figures show how the same type of layout can be adapted to suit local peculiarities of ground.

It might be argued that the somewhat rigid and rectangular designs indicated in the diagrams referred to above will afford ideal targets for attack from the air; this is to some extent true, but any attempt to scatter or unduly spread out the depot with a view to minimizing the effect of air attack requires so much railway construction and necessitates so excessive an amount of engine mileage within the depot itself, as to be unsuitable in practice except in the case of quite small depots. It is considered that the standard types shown in the diagrams should normally be adopted, the risk of air attack being met by adequate A.A. defence, by traversing and by fire precautions within the depots themselves.

The actual acreage required by the various services to accommodate their respective base depots will be effected by a variety of considerations: the scale of reserves to be maintained, the nature of the country, the topographical conditions, the size of the force, to name only a few. Bearing in mind the possibility of future expansion, which past experience has shown to have been seldom sufficiently realized at the beginning of a campaign, it would be as well to set aside areas on the following scale when first planning the general layout of a base depot area for a large force :—

For supplies	From 250 to 500 acres.
For ammunition	From 500 to 1,000 acres.
For transportation stores ...	From 100 to 200 acres.
For engineer stores ...	From 100 to 200 acres.
For ordnance stores ...	From 100 to 200 acres.

(Including workshop and returned stores depot.)

Petrol and oil require a special and separate sub-depot, on the scale of 150,000 gallons per division per month for all services, including R.A.F. This figure may

have to be increased as mechanization of the army proceeds. The proportion of oil to petrol is as 1 to 10. The petrol reserve should be forty-five days supply, when other stores are at thirty days supply.

The above figures can only be taken as a rough guide, as the circumstances will vary in each case, just as the organization of an expeditionary force will vary to meet the requirements of particular theatres of operations.

The bulk maintenance requirements of an expeditionary force of all arms may be calculated by allowing one-third of a ton a man a month for all maintenance stores, except railway rolling stock and heavy bridging material. This is based on an overall figure of 40,000 men per division, which allows for all ancillary services, and non-divisional, or L. of C. troops; while the stacking space required for most classes of stores can be taken as approximately one thousand tons to an acre.

Apart from store depots of various kinds, there are medical and hospital areas, personnel camps, remount and veterinary depots, and aerodromes to be provided for. The points to be considered in their location may be summarized as follows:—

Medical and hospital areas should be located well clear of the store depots and of the reinforcement camps. They require access to the broad-gauge railway, but should not be within five hundred yards of the main line. Their location should be convenient for the evacuation of casualties to the hospital ships.

Personnel camps should be within an easy march of the landing place and of entrainment stations. They are required in two parts—one for the temporary reception of units passing through and the other for reinforcements.

Remount and veterinary establishments should be located near each other in order to facilitate the transfer of animals. Not more than 2,500 animals should be grouped in the same locality. Veterinary provision should be made for from seven to ten per cent. of the animal strength of the force.

Aerodromes, apart from technical flying requirements, need both railway and road access for their stores and ground organization.

The Maintenance Project.

Turning now from questions of the siting and layout of base depot, the next task of the advance party to consider is the compilation of the Maintenance Project.

The first project is prepared before any reconnaissance has been made. In conjunction with the 1st Key Plan it forms the basis upon which the reconnaissance is carried out, and it is almost certain that considerable amendment will be necessary as the result of actual ground reconnaissance; the amendments will subsequently be embodied in the 2nd Key Plan and 2nd Maintenance Project.

This first project must not be too long, or too detailed; there is no time for detailed instructions at this stage. It is, however, all that the heads of services will have upon which to base their estimates for their requirements in the early stages of the overseas concentration. It must, therefore, contain sufficient instructions to co-ordinate the work of the administrative services on first landing. It is the basis upon which the embarkation and landing programme of the administrative troops, and the first consignments of matériel, will have to be framed.

To meet these requirements the Maintenance Project should :—

(i) Aim at defining the proposed limits of geographical responsibility of the various sub-area commanders by fixing the location of reserved transportation areas, hospital areas, base personnel camps, depot areas, etc.

(ii) Define the general policy for the movement of everything which is about to arrive in the port, whether personnel or matériel.

(iii) Provide a means of dealing with the immediate administrative problem on landing in respect of such items as medical, provost, traffic and supply services.

The 2nd Key Plan and Maintenance Project are prepared after reconnaissance; they cancel the first ones and give a more complete and more detailed picture of the organization and proposed working of the base area, correcting anything in the first project which reconnaissance has shown to be unworkable or inadvisable.

The Priority List of Sailings.

Based on the 1st Maintenance Project a priority list of sailings has to be prepared and arrangements set on foot for embarking the necessary units and stores. A priority list of sailings is a form showing the number and types of vessels required to reach the port of disembarkation each day and the particular nature of unit, or class of stores, with which each vessel is to be loaded. Owing to the necessity for speed, it will seldom, if ever, be possible to wait until reconnaissance reports are received from the overseas base. It is necessary, therefore, to appreciate the situation as it will be at the beginning of the landing operations and to arrange your list of sailings accordingly.

The original list of sailings must cover the period from the beginning of preparations for the dispatch of the force until the advanced party has arrived overseas, carried out its reconnaissance and cabled home its decisions. From that time onwards a new list of sailings can take effect, based on definite knowledge.

If the theatre of war is a distant one and the expeditionary force is small, it is probable, having due regard to the time factor, that the advanced party will hardly be in a position to influence the order of sailings to any marked degree, but for cross-channel work the order of landing and sailing of ships can be controlled to a much greater extent from the overseas base.

Consideration of the problem will show that exclusive of the advance party itself, but before the dispatch of the combatant troops of the expeditionary force, arrangements should be made to send forward certain ancillary units. These may be sent in part concurrently with the advance party, and in part as soon as possible after it. Also there are certain ancillary units (such as hospitals, workshops and supply units, etc.) which should receive a high priority in the order of dispatch of the expeditionary force, but not necessarily be sent before any of the combatant troops.

It is obvious that you can do little or nothing without transport. Engineer stores for port construction and transportation material are early requisites. Material without tools and tools without material are equally useless.

Finally—or perhaps it should be placed first of all—there is the problem of defence against attack by the enemy's air force: to what extent will it be advisable for A.A. defence units and R.A.F. units to have priority over all else in our list of sailings?

It will also be necessary to consider, in conjunction with the Board of Trade representative, the number and types of vessels available, the kind of cargo for which each is suited, and their speed.

Next must be taken into account the facilities, known or assumed, of the port of disembarkation. How many vessels of each type can the port deal with daily? Then there is the "rate of turn round" of each ship—that is the time taken to enter the port, unload the cargo, and clear the dock again. In the case of a tidal river this "turn round" is usually expressed in terms of tides.

These, then, are the considerations which must influence the compilation of a priority list of sailings:—

(i) The order in which units and stores are required to arrive.
(ii) The number and types of vessels available.
(iii) Capabilities of port of disembarkation.

(iv) Rate of " turn round " of each type of vessel.

With this information, the rest is a matter of form, and the following form is suggested as suitable :—

Serial No.	Type of Vessel.	Date		Nature of Cargo.
		Leave.	Arrive.	
	(*a*)	(*b*)	(*c*)	(*d*)
—	—	—	—	—
—	—	—	—	—
3.	A.C. Barge ...	—	21st	Canned petrol and oil.
4.	" C "	—	21st	1st A.A. Bty. R.A.
5.	" A "	—	22nd	1st Rly. Survey Unit, 1st Dock Coy.
—	—	—	—	—
—	—	—	—	—

(Serial Nos. 3, 4 and 5 are given merely as examples.)

Column (*b*) would normally be completed by the Admiralty representative in conjunction with the Board of Trade and in accordance with the known speed of the vessel. At the end of each day's arrivals on the form it is helpful to summarize the total number of vessels due to arrive that day ; this total must, of course, not exceed the capacity of the port. The number of ships which can be received on the next day will depend on the rate of turn round of those already in port, and the number of berths which will be available. If a vessel requires four tides to clear, the berth which it occupies will not again be available until the third day of disembarkation. The form is made complete by inserting at the top of it the rate of turn round, for each type of vessel, which has formed the basis of your calculations.

As regards the order in which units and stores are required to arrive, this might conceivably be somewhat as follows :—

(*a*) The advanced party as outlined previously in this chapter.

(*b*) Air defence troops (proportion of).

(*c*) L. of C. administrative units.

(*d*) Advanced parties of units and formations.

(*e*) Main body.

Supplies and stores are, of course, required concurrently with above.

The actual order of landing of the main body will depend on circumstances, but the following should be given early priority :—

Remainder of air defence troops.
One general hospital.
One composite railway company.
One reserve M.T. company.
Railway construction and operating troops.

Divisional supply and baggage companies should precede their divisions.

Some further notes that may be of assistance in the work of base organization are contained in Appendix 1, which follows.

Appendix 1.

Some points of detail in organization of base depots.

1. Base Ammunition Depots.

(*a*) *Amounts required as a First Supply.*

	Tons	Sq. ft. floor space
Boxed amn. for Q.F. guns and S.A.A.	5,500	37,000
Unboxed B.L. Amn.	1,500	16,000
Bombs, grenades and demonstration explosives	500	4,400
Miscellaneous and Smoke Amn. ...	750	9,000
Totals	8,250	66,400

When possible cover should be provided for all natures. A standard shed for a base ammunition depot is 300 feet by 30 feet. Sheds are arranged in groups 400 yards apart and with 100 yards between sheds. At the beginning of a campaign extemporized

arrangements will probably be necessary, and railway services may not be available. If so, the first necessity is road access to all dumps, so that lorries can reach the ammunition.

For each ton of ammunition to be stacked allow :—

(i) One square yard of good surface.
(ii) Six feet run of timber dunnage.
(iii) One and a half square yards of tarpaulin.

If a permanent depot is to be built, do not make temporary dumps on sites selected for sheds, as they will interfere with the building of the sheds.

(*b*) *Labour of Ammunition Depots.*—R.A.O.C. personnel is employed on supervision work ; in addition, labour is required for loading and unloading, stacking, sorting, etc. For continuous working over long periods a working basis of approximately 6 tons per man per day can be taken. For a base ammunition depot receiving and issuing two trains a day (760 tons in and 760 tons out) about 250 labourers will be required.

(*c*) *Ammunition for R.A.F.* is supplied through army ordnance service, a small R.A.F. detachment being attached to the base ammunition depot for technical supervision.

(*d*) *Ammunition Depots.*—A standard base ammunition depot would contain about 38,000 tons of ammunition of all natures. This would probably suffice for a force of from seven to ten divisions with normal complement of non-divisional troops and R.A.F. A depot of this nature will take from three to six months to build, according to amount of labour and material available. About one square mile is required for such a depot with its personnel camp. The site chosen should be at least a mile from any village, town or military installation liable to damage in case of explosion. In other respects the location of depots will depend on the requirements of the A.A. defence plan and on consideration of transportation facilities.

(*e*) *Ammunition dumps* in forward areas are constructed on the same general principles as base depots, but on a very much smaller scale, the question of concealment from air observation and minimizing of the effects of air attack assuming increasing importance. Road as well as rail access to such dumps is generally necessary. By arranging the ammunition in stacks of 100 and 200 tons, and allowing 100 yards clear between stacks, 1,000 yards of road will accommodate from 1,000 to 2,000 tons of ammunition.

(*f*) *Ammunition Trains.*—In the early stages of a campaign, and when operations are very mobile, *encas mobiles* (always undesirable from a transportation point of view) may be necessary for the maintenance of ammunition supply. These trains are depots on wheels, capable of movement at the shortest notice. The size of the ammunition train is limited by the capacity of railheads, and runs normally to about forty trucks (including any for personnel). This means about 350 tons of ammunition. When operations are more stable, ammunition trains are unloaded on arrival at railheads and the trucks are released; the ammunition being placed in dumps in the vicinity of, but at least half a mile from, the railhead, or being carried forward by M.T. to formations. It takes about two hours to clear an ammunition train (350 tons), the labour being provided by the local administrative commandant. Six trains a day represent the maximum for a well-equipped railhead, but three trains a day represent good working under normal conditions. In principle an ammunition railhead should be used for no other purpose.

2. Ordnance Stores Base Depot.

Amounts required as a first supply of maintenance stores would be three weeks' estimated expenditure, in addition to complete personal and unit equipment for one-fifth of the force. Say, 250 tons (D.W.) per division. The above would be for issue to fighting formations.

To this must be added stores for field use, such as barbed wire, field tools, rope, etc. Say, one cargo of bulk stores of this nature in the first instance.

Large amounts of tentage will be required early both for personnel camps and for base depot purposes.

Ordnance stores require one acre per thousand tons for stacking, and covered accommodation is most essential for many classes of stores—clothing and blankets, for eaxmple.

3. Engineer Stores. (Works Services.)

In first instance required in two sections :—

(i) Temporary depot handy to port for material required for port development (timber, tools, spikes, dogs, etc.).

(ii) Permanent Base Depot for all classes of material both for Base Area development and for field use. This latter should be near Transportation Base Depot, as latter will demand heavily for bulk stores.

Requirements for Port Development.—Thirteen tons per yard of quay constructed, including timber and fastenings.

Requirements for Base Development.—Allow 2,000 tons for all classes of material in first instance.

Requirements for Field Use.—Timber, 1,000 tons ; general stores, 1,000 tons per division (disregard cavalry).

Space required for stacking, 1,000 tons to an acre. Allow room for expansion.

4. Transportation Stores.

Bulk stores in the first instance, other than specialized stores such as rails, wheels, axles, spare parts, etc., are obtained from R.E. stores. Stores will be required for—

(i) Port development.
(ii) Base Area development.
(iii) Forward L. of C. construction.

Allow 70 to 100 acres for railway purposes, shops, etc. For railway development allow 500 tons of railway material for every mile of broad gauge track to be constructed, including spurs and sidings.

Allow 1,000 tons to an acre for storage space.

When circumstances admit, Ordnance, Transportation and Works depots should adjoin one another; there is much interchange of stores between them. They all require workshops.

Section 5. Movement of Stores by Rail.

As pointed out above, our stores on first landing in the docks at our overseas base port will normally go direct from the docks into the base depots, which are constructed clear of the dock area. The next point to consider is the manner of movement of the stores forward from the base along the lines of communication to the troops. This forward movement will be carried out by road, rail or inland water transport, according to circumstances, but in most cases it will be done in the first instance by rail. There are two systems in general use for forwarding stores by rail—the Pack Train or the Bulk Train. Diagram No. 6 shows the systems graphically.

Pack Trains are formed by collecting loaded wagons from all kinds of depots and installations—supplies, ordnance, postal, base laundries, M.F.O., etc.—and thus forming a train daily whose contents are destined for a particular formation, not for a particular railhead. The latter may change while the train is in transit on the lines of communication. Stores normally sent by pack train may be conveniently called " Pack Stores," and they are sent in accordance with specific demands made by units. The collection of the trucks which go to make up the pack train, and their formation into the complete train, are carried out at the Regulating Station.

Supplies for one division for one day weigh approximately 148 tons, and require seventeen to nineteen 10-ton

railway trucks to move. This includes hay, oats, meat, groceries, bread, mails, ordnance stores, petrol and oil, M.F.O. stores, coal, and N.A.A.F.I. stores, which comprise the normal contents of the pack train section for one division.

Supplies for one cavalry brigade for one day weigh approximately 53 tons, and require nine 10-ton trucks to move.

Normally two divisional sections go to each pack train. Corps and Army troops have special packs or are combined with divisional packs according to strength. On continental railways the maximum pack train would consist of forty-eight wagons and two brake vans.

When conditions admit, or operations are sufficiently stable, pack trains, in so far as R.A.S.C. supplies are concerned, may be made up as "standard packs," carrying the same quantities of stores each day; the balance of requirements to meet comparatively small fluctuations at railhead being sent up in a "variable pack." The adoption of this system very greatly facilitates the labour of loading up the trucks in the base supply depots.

Bulk Trains are full train loads, loaded homogeneously with one class of store, such as, for example, engineer stores, coal or road stone. They originate usually at one single base depot, and are destined for one particular railhead or locality. The contents of such trains are taken over by a formation at destination, inasmuch as if the formation changes location, it leaves the stores behind in the area it has quitted.

Bulk stores are generally "Area Stores" rather than "Formation Stores," though unit or formation stores may sometimes perform part of their journey in bulk, especially between depots and regulating stations.

The great difference between pack and bulk stores lies in the rail movement. With "pack" stores the formation and dispatch of the pack train is complicated by the fact that their component wagons—often containing perishable supplies—come from all over the

place, and yet the train *must* be dispatched from regulating station punctually to time, otherwise late arrival and disorganization of road transport services forward of railhead will result.

On the other hand stores travelling by " bulk " train are more simple to handle. The train can be made up complete in the Depot, and, provided the formation taking over the contents at railhead is warned in time of the day and hour of arrival, it does not matter within fairly wide limits which of the available railway timings is utilized :—

It follows from these conditions that—

(i) Everything possible should be done—for example, by convenient location of *unit store* base depots—to help the " pack " store transportation problem.

(ii) " Bulk " stores base depots can be located much more freely, transportation conditions being able to give way to a much greater extent to the requirements of holding services concerned.

A secondary deduction is—

(iii) When conditions permit, as much movement as possible should be done by " bulk " store. This, of course, may necessitate the formation of dumps in railhead areas.

In practically every case of bulk trains clearance must be effected into a railhead dump, because the bulk train must be released as quickly as possible, and because drawings of bulk stores are quite often in detail—*i.e.*, bulk is broken at railhead. Furthermore, if enemy air action is very effective, it may even be necessary to clear pack trains to railhead dumps in concealment, so as to reduce the visible activity actually in the station to a minimum. Railhead dumps must, of course, *not* be in the station, but well clear of the reserved transportation area of the actual railhead.

A question may arise in connection with the movement of petrol. If and when petrol is to be a bulk supply, it may require railhead storage in the form of *encas mobiles* of rail tank wagons. No other form of storage is likely to be practicable at railhead. In that case it will probably be best to treat petrol like ammunition and give it a separate railhead to itself. That is to say, to treat it as a " bulk " store. If, however, it is in cans—as probably it will always be necessarily for about 20 per cent. of consumption—it is best treated as a " pack " store, to be drawn from pack trains at supply railhead.

An important form of railway movement of stores is by *en cas mobile* train. That is, a train kept loaded with supplies, or petrol, or ammunition, which can be kept standing in a siding. It constitutes a mobile railhead dump, but it also constitutes a transportation crime. It locks up valuable railway rolling stock, which is never sufficient for all requirements. It takes up siding accommodation; it is conspicuous from the air, and may afford useful information to the enemy; it is sometimes dangerous and may require the construction of special sidings, as in the case of ammunition or petrol; yet as a mobile reserve it may be very valuable, if not essential; but it should never be resorted to without very good cause for the reasons just indicated.

Reference has already been made to the importance of balancing the traffic generally throughout the whole of a movement system, that is throughout the whole of our lines of communication. If one rules out railway accidents—*i.e.*, technical failures—the chief cause of any failure of the lines of communication in rear of railheads is late running, due either to too great length of line from base to railhead, or to over-burdening the capacity of the line. Both these matters, though in the first instance technical matters for the transportation service, are in point of fact staff matters, and if the transportation service, according to its duty, had brought either to the notice of the Staff, their continuance or

occurrence is a sure indication of bad staff work. What are the remedies should these difficulties arise ?

If the trouble is the length of the line, the Staff should have taken steps in good time for the establishment of a new advanced base farther forward. If due to overloading, the Staff should have seen to the reduction of military traffic, even though that would mean a reduction in military activity. Nothing is more fatal than to overload the line of communication, and in this matter very careful consideration must be given to the advice of the Transportation Service. This question assumes very great importance when, owing to actual physical difficulties, the capacity of a portion of the lines of communication is limited, as in the case of the North-West and Western Frontiers of India, in the event of a war in Afghanistan.

It must not be forgotten that the establishment of an advanced base not only brings into existence a new and important point to be defended, but also takes time to establish. During its establishment, too, it brings additional traffic on the lines of communication, for to build up the reserve therein requires a certain number of trains while the normal military traffic is still coming up from the base to railhead. The cure for the one cause of failure—length of line—may quite well precipitate the other—overloading the line—unless forward demands from the field army are reduced temporarily.

The capacity which must be set aside for the purpose of building up reserves is large and its amount is apt to be overlooked, especially if that reserve is required to be built up rapidly. It will be found that, if the communications are capable of maintaining a total of X divisions and Y weeks reserves for that number of divisions are required to be built up in N weeks, then the number of divisions that can be maintained during the period of building up the reserve is

$$\frac{N-Y}{N} \text{ multiplied by } X.$$

Although we have been considering the question of the

movement of stores by rail, similar principles apply when inland water transport takes the place of railways, or is used in conjunction with them.

In ports whose depth of water is not sufficient for large ships to be berthed they must lie off the coast or in the harbour, and the cargoes must be transferred to lighters. Our big ports do not suffer from this disadvantage, but it is a point to consider in connection with small ports which may become important in war. The lighterage equipment of such places must be sufficient to meet requirements, or it must be provided. Lighter work in harbour is one branch of inland water transport work, forwarding goods by river or canal into the interior is another.

The object of lighter work in harbour is to facilitate the loading or unloading of ocean-going shipping not provided with wharf accommodation, or as a supplementary service to hasten the unloading of ships at wharf-side. This lighter work requires careful organization, like any other service, but it is primarily a technical matter for the inland water transport director, and beyond general assistance in meeting the requirements of the service, the movement staff officer is not likely to be very much concerned with it. When, however, we have a Mesopotamian campaign or a Nile Expedition to deal with, where our lines of communication depend for the most part on inland water transport, then the soldier will find ample scope to exercise his ingenuity in dealing with the many problems which are likely to arise.

There is a great deal in inland water transport work which is highly technical, both in operating the fleet and in the preservation of the waterway, and this branch of the subject must be left in the hands of the technical expert. Success in operating depends largely on good time tables; these time tables are affected by tides, the opening of low swing bridges over canals, the number of tugs available—which number is rarely, if ever, sufficient—and the requirements for care and

maintenance of the waterway, which is easily thrown out of gear by floods, low water, weeds or silt. The preparation of the time table is better left to the technical man, but co-ordination in the common interest, especially where bridges are concerned, will often have to be undertaken by the movement staff.

The subsequent distribution of stores in front of railhead, which is usually a subject of local rather than of general administration, will be dealt with in later chapters when considering the questions of road transport and of maintenance.

6. Railheads and Regulating Stations.

In the preceding sections frequent reference has been made to railheads and regulating stations. The purposes they serve and the factors governing their selection and use will now be considered.

Railheads are the points on a railway system at which the requirements of the force in the field are delivered, for conveyance thence by other means of transport, and through which what is not required is evacuated to the base or other destinations. The output of a railway system is limited by the capacity of the railheads to deal with the traffic; any congestion at these points will seriously limit the output of the system as a whole. Care must be taken, therefore, to ensure that clearance facilities are provided on a sufficient scale to balance the reception facilities or to meet the quantities of goods that it is proposed to deliver at the railhead.

The chief commodities that have to be handled at railheads are—

(*a*) Ammunition.

(*b*) Supplies, including petrol, mails and ordnance stores.

(*c*) Personnel—*i.e.*, reinforcements, prisoners-of-war, leave personnel and troop movements generally.

(*d*) Ambulance trains.

(*e*) Road stone.
(*f*) Tanks and heavy artillery.
(*g*) Remounts and sick or wounded horses.
(*h*) Gun replacements.
(*i*) Engineer stores, such as timber, hutting material, bridging and similar appliances.

Some of these commodities are matters of daily supply, others are only required at intervals, but each type has its own special requirements, which should be considered when selecting and allotting railheads for the service of the various formations in the field. When facilities are adequate many of these commodities can conveniently be handled at the same railhead, but ammunition should invariably be allotted a railhead to itself. In future, when petrol may have to be dealt with in bulk and in very large quantities, also on account of its dangerous nature; it may be found desirable to work it at a separate railhead; under present conditions, however, petrol is most conveniently dealt with as one item of supply, and is handled at supply railhead in consequence.

During the war the French system of arranging railheads—in the early stages, at any rate—was to allot one large station to each formation for all purposes; while the British system was to allot various stations for the different natures of commodities. The latter system is considered to be generally the best; the French system is sometimes unworkable. Congestion is less likely to occur when several railheads are used for each formation, and the effects of bombardment from the air, or by long range guns, are lessened when all the eggs are not put in the same basket. Multiplication of railheads is, however, to be avoided. It produces more points requiring protection, necessitates additional staff organization for control, and may add to the technical railway difficulties as well. When very large and highly developed stations exist it may be possible and convenient to work two or more distinct

railheads in different parts of the same station, but this will seldom tend to smooth working in practice.

Congestion, or disorganization, of the railhead itself, apart from the effect of enemy action, should only occur if the railhead has been badly organized.

Causes might be—

(1) The attempt to make one station serve too many purposes—*e.g.*, for too many formations, or for bulk as well as pack train traffic.

(2) The attempt to avoid railhead dumps by keeping trains as *en cas mobile* while drawings were made in detail from them.

(3) Keeping too small an area as a reserved transportation area at the railhead, or placing railhead dump sites too close to the station.

(4) Neglect of road traffic organization in front of railhead.

All these are questions requiring the attention of the movement staff, and they clearly call for very close co-operation with the technical transportation people as well.

When operations are very mobile demands are less, and fewer railheads are required; larger numbers of commodities can then be dealt with at the same railhead. But as soon as operations stabilize demands of all kinds increase, and, for static warfare conditions, railheads will normally be required on the following scale :—

(*a*) Ammunition. One per corps. Must be separate.

(*b*) Supplies, mails, ordnance stores. One per corps.

(*c*) Personnel. Depends on circumstances; for strategic moves, three in each army or corps area. Small numbers of personnel can be dealt with at supply railhead.

(*d*) Ambulance. One to each group of casualty clearing stations—say, one per corps.

(*e*) Road stone. Two special sidings per corps.

(*f*) Tanks and Heavy Artillery. Depends on circumstances.

(*g*) Remounts. One per army.

(*h*) Gun replacements. One per army.

(*i*) R.E. stores. One siding per corps.

Railheads are normally selected in the first instance by Army Headquarters, in consultation with corps and divisions in the case of supply, personnel and ammunition railheads, but subject to ratification by G.H.Q., as railways, and consequently railheads, are a subject of general administration. Any officer may, however, be called upon to carry out a reconnaissance with a view to selecting a railhead, and the factors which influence their selections should therefore be fully understood. These factors are—

(*a*) The railhead should be suitable for the particular purpose for which it is selected.

(*b*) The railhead should be convenient geographically with a view to the reduction of road transport.

(*c*) The security of the railhead from ground and air attack.

(*d*) The possibility of its retention unchanged as long as possible.

As regards the desiderata of the different natures of railheads, the following points should be considered, though cases will often arise in practice, especially in undeveloped countries, where these requirements will not be forthcoming unless they are constructed by the army itself:—

An ammunition railhead should have sidings capable of taking the complete standard ammunition train at one time—that is, a siding 390 yards long. This is not so essential in the case of supplies, as the different sections of the supply pack can conveniently be dealt with in separate sidings, or one after the other.

The station yards should provide a minimum width of 40 feet of hard surface for the use of mechanical transport loading from the railway trucks. To construct such a yard, when this is necessary, sufficiently large to clear a complete ammunition or supply train will require 3,000 tons of road stone and the use of heavy rollers to make it; the time and labour involved is the measure of the time necessary to construct such a railhead.

Engineer stores and road stone, owing to their bulk and weight, are usually off loaded on to the ground; this blocks the siding for other loading purposes until the stones have been removed by road transport.

Platforms are not essential, but they are a convenience, especially for loading ambulance trains.

End loading facilities are practically essential for tanks and heavy artillery.

As regards the geographical location of railheads, it is desirable to have them as near the troops they serve as possible, consistent with their safety and the avoidance of road congestion, which might arise if too many formations were using the same railheads or the same roads to and fro.

With road transport as at present organized railheads should not normally be farther from delivery point (Unit 1st Line Transport) than a maximum of fifty miles. In conditions of static warfare they might reasonably be within twelve miles of the delivery point. They should in any case be beyond the range of the enemy's long range artillery. With the increasing efficiency of bombing attacks from the air, it will become necessary to provide efficient anti-air defence for railhead areas. The establishment of such defences necessitates considerable layout of communications, etc., and the tendency in the future will therefore be, more than ever, to avoid moving railheads; so we may expect to find them at times at extreme distances from the formations they serve.

Other points which are of considerable importance

in connection with railheads are the entrances and exits from the station yards, the road facilities in the area, and the existence or otherwise, in the vicinity, of parking places for mechanical transport and forming up places for troops and their first line transport. These and other requirements are summarized in Appendix 2 at the end of this section.

The military organization at a railhead will consist as a rule of the following personnel :—

(*a*) A movement staff officer whose primary duty it is to act as the channel of communication between the troops and the technical railway staff. It is through him that the military requirements of the situation are notified to the railway service.

(*b*) A railhead supply officer (R.Sup.O.) whose duty it is to receive the contents of the supply pack train on its arrival at S.R.H. and to issue the supplies to the supply officers of the various Maintenance Companies.

(*c*) A railhead ordnance officer (R.O.O.), who performs similar duties to the R.Sup.O. as regards ordnance stores, or has technical ordnance charge of an ammunition railhead.

(*d*) A representative of the Military Forwarding Service (M.F.O.), who deals with the various small consignments, parcels, kits of wounded officers, etc., passing through supply railhead.

(*e*) A railhead post office, normally controlled by a sergeant.

(*f*) A railhead supply detachment working under the R.Sup.O. at S.R.H.

(*g*) A section or more of an ammunition company, R.A.O.C., working under the orders of the R.O.O. at A.R.H.

(*h*) A labour officer and labour units as necessary for handling goods in transit.

The rules for working railheads are simple but important, their object being to prevent congestion occurring at the railhead. When there is any possibility of extensions of existing facilities becoming necessary, a reserve transportation area should be set aside for the purpose, all traffic being removed clear of this area.

Station yards should be kept clear, no transport being allowed to enter them until a train arrives for loading or unloading. Punctuality of loading parties and transport must be enforced.

No dumping of stores or ammunition should on any account be allowed on station premises.

At railheads where personnel is dealt with reception camps should be available within an easy march of the station.

Where remounts are dealt with, special facilities may have to be provided by way of portable ramps and cattle pens.

Regulating Stations.

We will pass now to the question of Regulating Stations, which fulfil most important functions in the railway working of the line of communication. It is at the regulating stations that the train loads of different commodities coming, perhaps, from widely scattered bases and dumps are received, broken up and reformed into various supply pack trains, which are then forwarded to the correct railheads. Railheads may alter constantly in accordance with changes in the tactical or strategical situation, and it is important to ensure punctual arrival of the trains at the correct railheads.

It is at the regulating stations, too, that the return traffic from the front is received. This traffic consists of a great variety of types such as mails, kits, empty ammunition boxes and petrol tins, sick horses, damaged stores and vehicles for repair, and salvage of all sorts. These items are sorted in the regulating station, and sent on to their correct destination, and from here, too,

the distribution of empty rolling stock to the various depots for reloading is carried out.

All this work necessitates the handling of very large quantities of rolling stock, which has to be shunted and marshalled into trains. Possibly upwards of 480 trucks both ways will be dealt with in twenty-four hours. Large stations with ample shunting facilities are therefore required, or new marshalling yards may have to be constructed for the purpose, which requires a considerable area of flat ground.

Regulating stations should be conveniently located both as regards the position of the bases and of the railheads, and they should be centrally placed on the main line of advance.

To meet the above requirements regulating stations are required—

(*a*) In advance of the base depots for the formation or marshalling of trains, and for regulating the flow of both pack and bulk trains along the main line of communication.

(*b*) In front of any advance base, or branch feeder lines, for the same purpose as in (*a*) above.

(*c*) In rear of the railhead area to regulate the distribution of main line traffic to railheads.

This last type of regulating station controls what is sent up from the base depots, or from other points of origin, in accordance with changes in the situation of, or the actual situation at, the points of delivery—*i.e.*, the railheads. Dispatches must be controlled in accordance with the situation from time to time, otherwise congestion is sure to arise. To enable this to be done efficiently the regulating station should not be more than six hours' run in rear of the railheads.

All the above three types of regulating stations may quite often be combined in one; it depends on the length of the line of communication, and the relative positions of depots, advanced bases and railheads.

The three primary functions of the regulating station

are therefore—firstly, to build up the pack trains; secondly, to ensure that the pack trains arrive at the correct railheads at the right time; and, thirdly, to distribute the return traffic to the correct destination. It will be obvious, too, that they fill very important functions in the general regulation of railway traffic.

Appendix 2.

Points for consideration in reconnaissance of railway stations.

1. Approaches.

To the station, general road and traffic facilities, and *forming up places* for troops and M.T. in the vicinity.

Entrances and exits to and from the station yard.

Any special traffic difficulties, such as *level crossings or bridges.*

Entrances to and exits from platforms.

Possible effect of bad weather on approaches and forming-up places.

2. The Yard.

Size, shape and condition of surface. Facilities for M.T. unloading trains. Minimum width to serve one train, 40 feet; to serve trains on either side, 60 feet. A very good and strong surface required for continuous use of yard in bad weather.

3. The Line.

Single or double or more through lines. Main—junction or branch.

4. The Sidings.

Total length; length with road approach; length without road approach—*i.e.*, holding or garage sidings. Turntables.

Length opposite each end loading bay.

Lengths are best given in truck capacity clear of cross-over points (four-wheeled truck measures 28 feet over buffers, therefore 10 trucks require $93\frac{1}{3}$ yards; say, 10 trucks 100 yards for safety, or 10 yards a truck).

Lengths between crossing loops in sidings and on running lines. Shunting facilities. Marshalling yards. Facilities for extension.

5. Platforms and Unloading Bays.

Length, breadth, height, number; suitability for tanks, heavy artillery, transport, horses, ambulance purposes; exits and entrances.

6. Miscellaneous.

Station buildings for offices; goods sheds; cranes and their capacity; lighting facilities; water facilities for engines and in station buildings. Latrine accommodation. Entraining facilities such as ramps and horse brows; fuel and repair stocks.

7. Vulnerability to Air Attack.

Any points such as comparative conspicuousness, conformation of ground.

8. General Points.

(*a*) A sketch plan almost an essential part of a reconnaissance report; scale, say, 60 yards to 1 inch, showing station, yard, sidings, road approaches, etc.

(*b*) Report should give general description, and should state facilities for extension and type of traffic for which best suited on lines of requirements in next paragraph, and having regard to tactical considerations in addition.

9. Types of Military Requirements.

(*a*) *Troop Movement.*—Trains of 50 vehicles and engine; total length, 470 yards. Platforms not essential if portable vehicle and horse ramps available. Simultaneous loading of animals, vehicles and personnel desirable.

(*b*) *Supply Railhead.*—Normally pack train consists of two sections, each 16 to 17 trucks. Each section requires 170 yards of unloading frontage on the yard plus garage siding for remainder as a minimum.

(*c*) *Ammunition.*—Trains normally 37 to 39 trucks; requires, say, 400 yards of unloading frontage on yard for simultaneous unloading throughout length of train.

(*d*) *Ambulance.*—Train requires 300 yards of loading frontage, and platforms are a great assistance.

(*e*) *Tanks, heavy artillery and M.T.* must have end loading facilities.

(*f*) *R.E. material and stone* require 400 yards of siding of any type, but must have good removal facilities for stores or stone.

N.B.—No loading or unloading should be allowed on the main through running lines.