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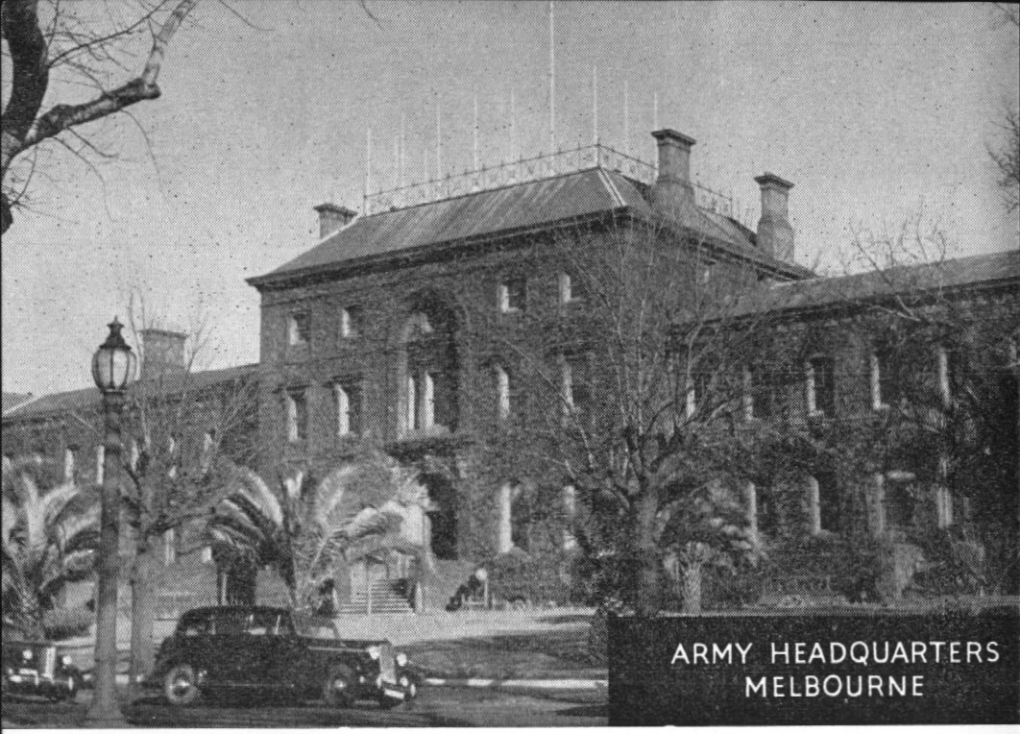
CONTENTS



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AUSTRALIAN ARMY JOURNAL

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Background to ....

KOREA

UNTIL 1895 Korea was under nominal Chinese suzerainty. At the turn of the century Japan's victories over China and Russia won Korea for her as a "sphere of influence," and in 1910 Korea was absorbed as an integral part of the Japanese Empire. An intensely nationalistic people, the Koreans never fully accepted Japanese rule and maintained a "government in exile" in China up to the end of World War II.

At the Cairo Conference in December, 1943, the United States, United Kingdom and China agreed that, "Mindful of the enslavement of the people of Korea we are resolved that Korea shall become free and independent." This declaration was re-affirmed by these powers, and subscribed to by the USSR at the Potsdam Conference of July. 1945.

Although at the time they were agreed to, these resolutions were directed towards the elimination of Japanese control over Korea, it was clearly the intention that the country should become free and independent of any outside influence. If the USSR had any reservations in mind she carefully refrained from mentioning them.

When Japan was defeated in 1945, American and Russian forces occupied Korea to disarm and take into custody the Japanese military forces there. To avoid confusion an immediate military decision defining zones of responsibility for the American and Russian forces became necessary. The 38th parallel of latitude was agreed upon as the dividing line between these zones, the Russians to disarm the Japanese troops to the north of it and the Americans to act south of it. This line had no geographical, political or economic significance whatever. It was nothing more than an arbitrary boundary between the American and Russian forces engaged in military operations.

In December, 1945, the Foreign Ministers of the United Kingdom, the United States and the Soviet Union, assembled in conference in Moscow, agreed that a provisional democratic government should be established for all Korea. The Moscow Agreement, to which China gave her adherence, provided that the American and Russian Commands in Korea were to form a Joint Commission which would consult with democratic parties and social organizations in Korea and make recommendations to the four Powers for the formation of a provisional democratic Korean Government, and to submit proposals for a four-power trusteeship lasting up to five years.

As soon as this Joint Commission met in Seoul in March, 1946, it be-

came obvious that the USSR was determined to secure the domination of Korea by the Communists.

Having suffered a long period of Japanese domination, the vast majority of Korean parties were unwilling to accept proposals for a trusteeship. The Communists immediately siezed the opportunity to declare in favour of a trusteeship, and the Soviet followed suit by refusing to deal with any party opposed to the trusteeship plan. If the Americans had conceded this point the way would have been left clear for the domination of the provisional government by Communist-controlled organizations. Consequently the Americans refused to give way and the conference adjourned sine die in May, 1946, without being able to agree on a report. Re-convened in the spring of 1947, the Commission again deadlocked on the same point and broke up without a decision.

Efforts by the United States military commander in Korea to reach the basis of an agreement with his opposite number in the Soviet zone proved equally unsuccessful.

In August, 1947, the USSR rejected a proposal by the United States that the four Powers should again confer with a view to seeking a solution of the problem. Consequently the United States Government laid the whole question of Korean independence before the General Assembly of the United Nations on 17 September, 1947.

A few days later the Soviet suggested to the United States that American and Russian troops in Korea should be withdrawn simultaneously "during the beginning of 1948.". This suggestion was rejected by the United States on the ground that the withdrawal of occupation forces from Korea should be considered as an integral part of the solution of the whole problem which was then before the United Nations Assembly.

Subsequently the United Nations appointed a Commission to:—

- Travel, observe and consult with the people of all Korea with a view to forming a Korean Government.
- Supervise the election of a Korean National Assembly comprising representatives from all Korea.

The UN Commission, consisting of representatives from Australia, Canada, Chile, El Salvador, France, India and the Philippines, assembled in Seoul in January, 1948. The representative of the Ukranian Soviet Republic did not attend.

The Russians refused to allow the Commission access to North Korea. This action made it impossible to hold an all-Korean election so the Commission referred back to the United Nations for a direction. The UN, by 31 votes to 2, resolved that national elections should be held in the south.

Accordingly, on 10 May, 1948, elections for 200 seats in the National Assembly were held under the supervision of the UN Commission. The elections resulted in the formation of a government under the leadership of Dr. Syngman Rhee. In assessing the representative nature of this government it should be borne in mind that 20,000,000 of the 29,000,000 Koreans live south of the 38th parallel. About 92.5 per cent. of South Koreans voted in the election.

The government elected under the supervision of the UN Commission was recognized by the United Nations. In April, 1949, however, the Soviet Union exercised the veto to block the application of the Korean Republic for membership of UNO.

Almost simultaneously with the establishment of the Republic of Korea, another government was brought into being under Russian aegis in the northern zone. This government, which was elected under the usual "rules" obtaining in Soviet satellite countries, named itself the Supreme People's Council of the "Democratic People's Republic of Korea," and claimed jurisdiction over the whole country.

In December, 1948, the USSR announced the withdrawal of its military forces from North Korea. They left behind a Soviet trained North Korean army of 200,000 troops equipped with Russian and Japanese weapons, including planes and tanks.

The last of the United States forces were withdrawn in July, 1949. At the request of the South Korean Government they left behind a small military advisory group to assist with the organization and training of a Korean force of about 96,000 troops for the maintenance of internal order and border security. American equipment was made available to the Republic for the use of these troops.

On 25 June, 1950, North Korean forces crossed the 38th parallel in strength with the apparent object of seizing the entire peninsula and placing it under control of the Soviet backed North Korean Government. The Security Council of the United Nations immediately called upon the invaders to cease hostilities and withdraw to the 38th parallel. They took no notice. The Security Council then called upon all members of the United Nations to render assistance to the South Korean Government in its efforts to resist the aggression.

In response to the resolution of the Security Council, the President of the United States issued an order to the American Navy and Air Force directing them to cover and support the South Koreans. The order was made applicable to the United States Army on 30 June. American forces in the Far East immediately proceeded to execute this order by going to the assistance of the South Koreans. These slender forces have since been reinforced by formations and units despatched from the United States.

On 28 June the British and Australian Governments placed naval units in the Far East at the disposal of the American Commander, General MacArthur. On the same day the Australian Government placed 77 Squadron, RAAF, then stationed in Japan, under General MacArthur's operational command. This squadron made its first sortie in Korea on 2 July.

On 7 July UNO requested the United States to appoint a commander for the UN forces operating in Korea. The American Government appointed General MacArthur, who thus became the commander of the United Nations forces in the Far East. In the meantime the United Kingdom, Canada, Australia and New Zealand had undertaken to provide additional forces, including ground troops.

FIVE MINUTES TO TWELVE

Directorate of Military Training.

IT is often argued that history does not repeat itself. Protagonists of this notion usually confine their arguments to narrow fields of study, to the history of individual nations or particular fields of human endeavour. Within these narrow limits, and often mistaking the appearance of things for the reality of things, they are sometimes able to make out a plausible case in support of their argument. But the histories of nations are not intelligible fields of investigation unless they are studied in relation to the setting in which they are placed —the history of the civilization which includes them in its orbit. And, in this wider field, this more comprehensive story of human development, the argument breaks down.

We can identify 21 civilizations or societies which have reached, or are in process of reaching, full development. Of these, seven are living co-existent in the world today and 14 are extinct. Of the 14 extinct civilizations, two—the Yucatec and Mexic—were fused by Aztec conquest to form the Central American, which was utterly destroyed by the Spaniards in the sixteenth century. One—the Andean—was destroyed by the same tide of European conquest. Two — the Iranic and the Arabic—were fused by Moslem military conquest and missionary zeal to form the living Islamic Society. The remaining 10 extinct civilizations all completed a full life cycle from genesis to decay.

Examination of the 10 civiliza-

tions which have run the full course reveals a striking similarity in the paths they followed. A definite pattern, a life cycle, establishes itself. Without exception these societies have all passed through the successive stages of genesis, growth, breakdown and disintegration. And, again without exception, each of the successive stages has been brought about and carried through to its conclusion by similar influences.

Birth and Growth.

Our examination shows that the reason for the birth and growth of civilizations may be expressed in the phrase "challenge and response." The initial challenge may be caused by external forces, by the environment in which the embryo society finds itself, or by a combination of both. Thus, the gradual drying up of the once fertile grazing lands of North Africa presented the inhabitants with a physical challenge of increasing severity. They responded by clearing the swamps in the Nile valley, and in so doing laid the foundations of the Egyptiac Civilization. Similarly, the inhabitants of the western portion of the ruins of the Roman Empire were faced with a dual challenge—new ground and the disintegrating Hellenic Society, which was the basis of Roman culture. Their response gave birth to our existing Western Civilization.

The growth of a civilization is due to a continuation of the process of challenge and response. The first successful response produces a new challenge, which calls for a new response. As each successive challenge is met the way becomes clear for a fresh advance. On the other hand, failure to meet a challenge does not remove the difficulty. The challenge remains and if it is not ultimately overcome the civilization breaks down and decays.

Breakdown.

The Hellenic Civilization was born of the dual challenge of a barren land and the disintegrating Minoan Society which preceded it in the islands of the Aegean Sea. After a period of growth it was presented with the challenge of overpopulation. Athens responded successfully by specializing her products for export, establishing commerce and reorganizing her social structure to provide for the new classes thus brought into being. She then enjoyed a period of extraordinary intellectual brilliance and material prosperity. But the new conditions produced a new challenge. They demanded a higher political organization than the independent city states of which the society was composed. The challenge proved too severe, the Greeks failed to produce a solution, and the Hellenic Society entered a period of bitter internecine wars which marked the beginning of its decline.

The period of internecine warfare ended in the establishment of a universal state imposed on the Hellenic world by the military power of Rome. The inertia brought about by the universal peace imposed and maintained by military conquest produced a further decline in the quality of leadership. The ultimate result was the disintegration of the Hellenic Society into the chaotic interregnum which formed the breeding ground for the new society, which we know as our living Western Civilization.

Life Cycle.

Every one of the ten extinct civilizations which completed the cycle followed a similar course, a fact which is all the more striking because they were dispersed in space and time. The circumstances which produced the successive challenges, and the nature of the challenges, varied widely. But in each case the chain of cause and effect followed a similar course and produced a similar result. The chain of cause and effect thus established invariably conformed to the following phase pattern:—

Genesis.

A civilization is born as the result of a successful response by a primative or chaotic society to the challenge of the circumstances in which it finds itself.

Growth.

A period characterized by a series of successful responses to the challenges exerted by environment, social and technological discoveries, economic pressures, external pressures or any other cause. Successful responses are expressed in terms of social, political and cultural creativity.

Breakdown.

The breakdown of a civilization takes place in two sub-phases. Failure to respond to a challenge produces a "Time of Troubles," usually characterized by internecine warfare between the constituent parts of the civilization. This is followed by a "Universal Peace" imposed through the agency of a "Universal State" brought into being by military conquest.

Disintegration.

The authority of the universal state declines, the state breaks up and the society degenerates into chaos.

Failure of the Leaders.

Observing closely the life cycle of the extinct civilizations we are profoundly impresed by the all-important part played by leadership. We become aware that all these societies have been composed of two main groups—the leaders, who constitute a minority, and the mass of the people. Throughout the processes of birth and growth the leaders constitute a creative minority. So long as this minority remains creative, so long as its members lay more emphasis on the responsibilities of leadership than on its privileges, and so long as they continue to find solutions to successive problems, the society maintains its cohesion and forward impulse. Leaders and led blend together and, in their respective spheres of activity, direct their energies towards still higher achievements.

The initial breakdown occurs when the leaders fail to perform the function which their place in the society demands of them. From being a creative minority they become merely a dominant minority, jealously guarding their privileges, but failing to discharge their responsibilities. Schism appears in the body social and the civilization goes into a decline, a decline brought about by the failure of the leaders.

Failure of the leaders is always characterized by a loss of faith in the spiritual values which gave the society its cohesion and forward impulse. Long after they have finally abandoned the faith of their fathers

the leaders continue to pay lip service to it, to go through the old drills, the old motions, of spiritual exercise. From its habit of mimesis the mass follows until it is too late to turn back from the fatal road to extinction. Standards of conduct decline, the ethical code degenerates into indifference and cynicism, morale is progressively weakened until it can no longer sustain the society in a struggle against a strong physical challenge.

It is important, also, to note another constantly recurring phenomenon. There is an apparent continuation of growth after the actual point of breakdown has been passed. A society may continue to produce brilliant technological achievements even whilst it is in decline. The progress of civilizations is not measured in terms of technical discoveries, which, indeed, often themselves constitute a formidable challenge. If progress is to continue these discoveries and processes must be expressed in terms of cultural achievements and social values and relationships.

Western Civilization.

Because we are so close to the events of our own times, because we are participating in them, it is not easy to say what point Western Civilization has reached. We can clearly discern the origins of our society amongst the ruins of the disintegrating Hellenic Civilization. We can follow the dramatic story of successive challenges and responses, the evolution of the feudal system from the chaos which followed the collapse of the Hellenic universal state (Roman Empire), the great counter-offensive against the Saracenic onslaught of the sixth and seventh centuries, the overseas expansion of Western culture brought about by the pressure of population and unjust social codes. We know that we have not yet arrived at the phase of the universal state. But, when we consider recent history we may well conclude that we are already far advanced in our time of troubles.

If internecine warfare is a characteristic of a time of troubles, the wars which have riven Western Civilization for the last 150 years provide strong evidence that we have at least entered a period of grave crisis. However, even if we do conclude that we are in the midst of our time of troubles it does not necessarily mean that we are doomed to follow the ten civilizations that have gone to extinction along the same fatal path. No chain of causation is complete until it has produced its final effect. And a civilization is not an animal organism, condemned by an inexorable destiny to die after traversing a predetermined life curve. Civilizations are composed of human beings, and human beings are blessed with the gift of free will, a gift which they can exercise, if they choose, towards the attainment of their own salvation.

Because man is free to choose his destiny we cannot deduce from the study of history an immutable law governing the lift cycles of civilizations and setting a limit to their terms of existence. But we can say that all the ten extinct civilizations followed a similar course and that they followed it for similar reasons. It seems an inescapable conclusion, therefore, that if we fail in the same respects as they failed, if we fail to produce a successful response

to a major challenge, we must share their fate.

If this be so we should now endeavour to assess the nature of the challenge which confronts us today, and determine the course of action necessary to meet it.

Challenge to the West.

Two almost exactly analogous examples can be drawn from the history of Western Civilization to illustrate the situation in which we find ourselves today.

In the sixth and seventh centuries the Saracens, from their bases in Asia Minor, over-ran the outposts of the West in the eastern Metiterranean and north Africa, crossed into Spain and Sicily, and threatened the very heart of Christendom. At the time Christendom was in no fit state to meet this powerful external challenge because it was menaced by an equally grave threat from within. Leadership was at a low ebb, spiritual faith was waning, selfishness, cynicism and materialism pervaded society from top to bottom.

As the ramparts fell one by one. as the seemingly irresistible tide of conquest flowed westward and northward, distraught Christendom looked into its soul and saw there the rottenness of decay. But Christendom, saw, too, what had to be done, first to arrest the decay and then to defeat the enemy hammering at the inner keep. Men returned to the God of their fathers, and from that Source of spiritual strength a great wave of faith swept over Europe. Leadership threw off its torpor and assumed its responsibilities. No price was too high, no sacrifice too great, no labour too heavy. From renewed moral strength Christendom drew renewed physical vigour. The tide of Saracenic conquest was held and then in a great counter-offensive, driven back almost to the place from whence it came.

Five centuries later the Saracenic onslaught was renewed under the leadership of the Ottoman Turks. The new attack caught the West in the same demoralized state as the first. Christendom produced the same response to the dual challenge, though not quite on the same scale. The counter-offensive died away before it reached the Bosphorus.

Reading a bare outline of these events on a few pages of a history book, we fail to appreciate the immensity of the efforts made by Western Civilisation on these two occasions. The great proportion of the available energy directly devoted to the war, and the length of time over which the efforts were sustained, constitute feats of sacrifice and endurance which have seldom been surpassed. On both occasions Western Civilisation responded to a dual challenge with a veritable *tour-de-force.*

It is not hard to see the external challenge facing us today, though its nature is often misunderstood and its magnitude underestimated. In our time of troubles we have become so used to internecine strife that we are apt to think of the conflict with Russia as a dispute between two rival groups of nations. It is much more than that. It is a collision between two utterly incompatible civilizations which have nothing in common except their common humanity. In their concepts of the purpose of life, and of spiritual and

cultural values and social relationships—the things which constitute a civilization—they are further apart than Saracen and Christian, who worshipped the same God in different ways and under different names, and whose codes of morality were therefore generally similar. But the ambitious, ruthless men who are directing the onslaught on the West today, and for the most part the men who carry it out, worship no God at all. They look at life through pagan eyes, their philosophy is based on atheistic materialism and their laws on pure expediency. The morale which sustains them and drives them on is an amalgam of a satanic lust for power, the *élan* of the barbarian war bands in their tidal waves of conquest, and the deep, ancient ambition in the Russian soul, "Mother Russia" on the march at last to accomplish her messianic mission of regenerating the world.

Materially our adversaries are very strong, stronger perhaps than we are. They possess great physical resources and they command the allegiance of vast numbers of men eager to do their bidding. To crush the challenge, even to deflect the blow, will require an immense and sustained physical response comparable in scope and intensity to the greatest efforts ever put forth by Western Civilization.

Shall We Respond?

Are we of the West in a fit moral condition to meet the challenge? Have we sufficient spiritual strength to sustain the sarcifices, the exertions, necessary even to maintain our position, much less to carry us to decisive victory?

It may well be doubted. How long is it since we abandoned, in practice if not in theory, the moral standards of the faith which is the basis and inspiration of our civilization? How long is it since we made the pursuit of material aims, of personal aggrandizement, the sole purpose of existence? Few generations have listened so attentively to loquacious intellectuals whose shallowness of thinking is equalled only by their facility of expression, to scientists deifying their own discoveries, and to mathematicians peddling pseudo philosophies. Dazzled by the brilliance of our technological achievements, we are fast losing the ability to distinguish between the superficial and the fundamental.

If we are to meet the external challenge, the most powerful, the most threatening, challenge the West has ever faced, we must return to the faith of our fathers, to the spiritual and ethical basis of our civilization. For in that faith alone can we find the inspiration and the moral strength necessary to sustain us through the labours, the sufferings, the disasters that surely lie ahead.

In this crisis the responsibilities falling on leaders at all levels are very great. Not only do they have to show without equivocation what has to be done, but they have to take the lead in doing it. Leadership, therefore, must be positive and dynamic, in the spiritual sphere as well as in the physical. We must return to the God of our fathers, to the old knightly virtues of Christian faith, of devotion to our cause and self-sacrifice in its realization. Only by these means can we overcome the internal challenge, an essential re-

quirement for the defeat of the external challenge.

Because we have travelled so far along the road to apostasy, effective leadership in the spiritual sphere, in a return to the faith and practice of Christianity, will require great moral courage on the part of every leader. If we fail to give this leadership Western Civilization will surely go down to extinction, in all human probability in our time, in a holocaust of suffering and destruction transcending anything ever perpetrated by the Mongol ancestors of our present assailants.

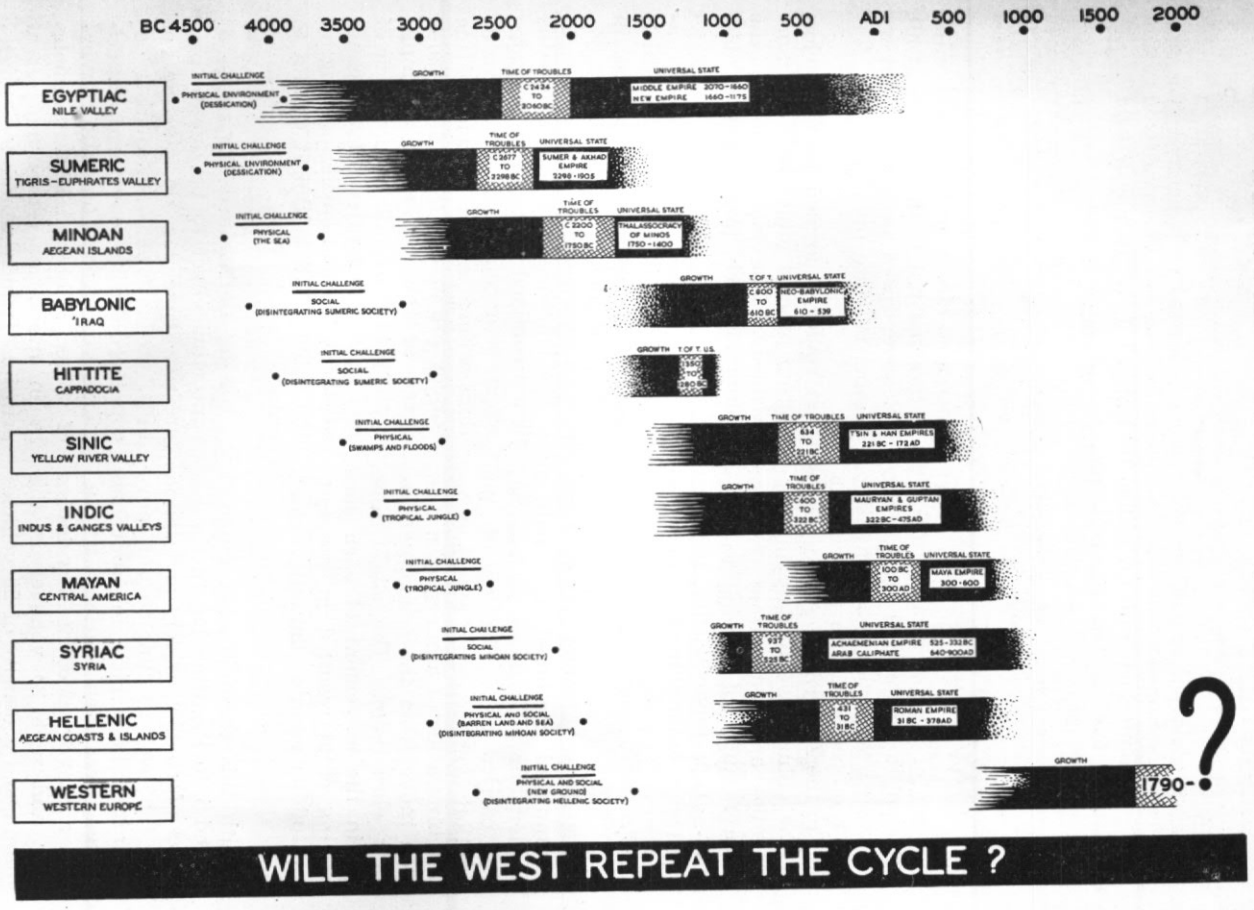
It can be done. Our forebears twice accomplished a similar feat. Shall we be lesser men? Will our children remember us with honour and gratitude, or with aversion and contempt?

If the moral and physical exertions demanded of us are great, the rewards offered by success are greater still. Victory over the dual challenge may well give Western Civilization, for the first time for centuries, the chance of a universal peace imposed by agreement rather than through the agency of a universal state established and maintained by military conquest.

Let us then accept the challenge with a good heart. In the spirit of the Christian knights who carried the banners of their faith to victory, let us find the inspiration to give the leadership demanded of us now, saying with Rupert Brooke—

"Now God be thanked Who has matched us with His hour,
And caught our youth, and wakened us from sleeping,
With hand made sure, clear eye, and sharpened power,
To turn, as swimmers into cleanness leaping . . ."

There is still time to do these things. But time for the West is running out. It is, in fact, rather less than five minutes to twelve.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GROWTH
TIME OF TROUBLES
C 3434 TO 2040 BC
UNIVERSAL STATE
MIDDLE EMPIRE 2070–1640
NEW EMPIRE 1640–1175
SUMERIC
TIGRIS–EUPHRATES VALLEY
INITIAL CHALLENGE
PHYSICAL ENVIRONMENT (DESSICATION)
GROWTH
TIME OF TROUBLES
C 2677 TO 2298 BC
UNIVERSAL STATE
SUMER & AKKAD EMPIRE
3298–1905
MINOAN
AEGEAN ISLANDS
INITIAL CHALLENGE
PHYSICAL (THE SEA)
GROWTH
TIME OF TROUBLES
C 2200 TO 1750 BC
UNIVERSAL STATE
THALASSOCRACY OF MINOS
1750–1400
BABYLONIC
'IRAQ
INITIAL CHALLENGE
SOCIAL (DISINTEGRATING SUMERIC SOCIETY)
GROWTH
T OF T
UNIVERSAL STATE
C 600 TO 610 BC
NEO-BABYLONIC EMPIRE
610 – 539
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CAPPADOCIA
INITIAL CHALLENGE
SOCIAL (DISINTEGRATING SUMERIC SOCIETY)
GROWTH
T OF T
U.S.
1380
TO
1340 B.C.
SINIC
YELLOW RIVER VALLEY
INITIAL CHALLENGE
PHYSICAL (SWAMPS AND FLOODS)
GROWTH
TIME OF TROUBLES
UNIVERSAL STATE
634 TO 221 BC
TSIN & HAN EMPIRES
221 BC – 172 AD
INDIC
INDUS & GANGES VALLEYS
INITIAL CHALLENGE
PHYSICAL (TROPICAL JUNGLE)
GROWTH
TIME OF TROUBLES
UNIVERSAL STATE
600 TO 322 BC
MAURYAN & GUPTAN EMPIRES
322 BC–475 AD
MAYAN
CENTRAL AMERICA
INITIAL CHALLENGE
PHYSICAL (TROPICAL JUNGLE)
GROWTH
TIME OF TROUBLES
UNIVERSAL STATE
100 BC TO 300 AD
MAYA EMPIRE
300 – 600
SYRIAC
SYRIA
INITIAL CHALLENGE
SOCIAL (DISINTEGRATING MINOAN SOCIETY)
GROWTH
TIME OF TROUBLES
UNIVERSAL STATE
937 TO 721 BC
ACHAEMENIAN EMPIRE 525–332 BC
ARAB CALIPHATE 640–900AD
HELLENIC
AEGEAN COASTS & ISLANDS
INITIAL CHALLENGE
PHYSICAL AND SOCIAL (BARREN LAND AND SEA) (DISINTEGRATING MINOAN SOCIETY)
GROWTH
TIME OF TROUBLES
UNIVERSAL STATE
331 TO 31 BC
ROMAN EMPIRE
31 BC – 378AD
WESTERN
WESTERN EUROPE
INITIAL CHALLENGE
PHYSICAL AND SOCIAL (NEW GROUNCE) (DISINTEGRATING HELLENIC SOCIETY)
GROWTH
1790–
?
WILL THE WEST REPEAT THE CYCLE ?

CONVOY CONCERTINA

Condensed from an article by Colonel J. W. Bishop, OBE, in the Canadian Army Journal.

WHILE on the Headquarters of 5th Canadian Armoured Division in England, I was deeply impressed with the speed my Hup. was required to attain to keep station in the AQ group. As thirteenth in the column we usually hit over 50 miles an hour within two or three minutes of leaving the harbour. The convoy leader, however, invariably assured me that his speed had never evceeded 20 miles an hour.

The cause of over-speed of the column tail continued to remain a mystery until a thorough analysis was carried out. The key to the solution was actually obtained by watching a file of kindergarten children move from the school-yard to their class-room. The slight time lag in the movement of each succeeding child resulted in the tail-end toddler running flat out to catch up.

With this example as a guide, I looked into the time lag in the reflexes of convoy drivers and found that the average time to get moving after the vehicle in front had started was ten seconds. Thus, with a convoy speed of 20 miles an hour and with 20 vehicles in the column and a density of 20 vehicles to the mile, the column length is increased from one to two miles before the tail vehicle moves at all. The over-speed occurs when it attempts to close up.

It could be argued that the closing-up process might be done more leisurely. The fear of losing the column is such, however, that, despite rules and regulations, and even despite the best possible road control and the issuing of route cards and maps, drivers still persist in trying to catch up quickly.

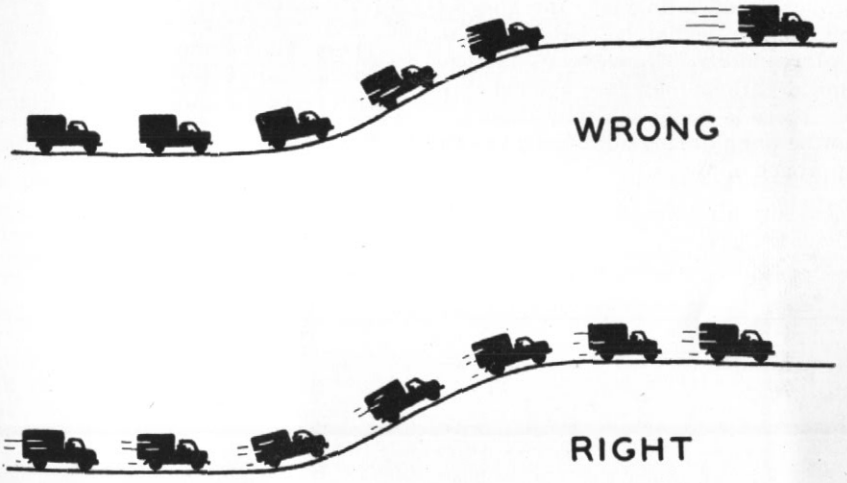
The lengthening of the concertina is not confined to starting. The same effect is encountered under conditions where certain vehicles of the convoy are unable to hold the same speed as the leader; for example, a steep or long hill, or a stretch of bad road. Regardless of the cause of the extension, over-speeding of the column tail is almost certain to ensue.

Having determined the cause of concertina effect to be due to progressive time lag on starting, or hills, or bad roads, or defiles, encountered during movement, experiments were carried out with convoys of mixed light and heavy vehicles in an attempt to establish a set of principles which would tend to retify the trouble.

The starting problem was solved largely by adopting a system of signals designed to reduce the lag between movement of successive vehicles. The first signal meant in effect, "Start your motor and begin to move immediately you detect movement ahead." On receipt of the acknowledging signal from the rear the leader moved off, and the entire column was found to be under way in about 20 seconds instead of three minutes.

This procedure was later defined by adoption of the principle that the convoy leader should accelerate slowly to half convoy speed, hold that speed for one minute for every ten vehicles in the convoy and then accelerate, again slowly, to rated convoy speed. A combination of these drills was found to be thoroughly effective in holding the column to its proper density and avoiding over-speeding of the tail.

In the course of experimentation, and to prove conclusively that time lag was the culprit, the column was moved off several times tail first. In other words, the last vehicle moved off at the moment it acknowledged the standby signal. Each successive vehicle followed suit, the leader moving last of all. This resulted in a slight temporary shortening of the column, but permitted it to accelerate quickly to rated speed, without hesitation at half-speed and with no signs of over-speed. The disadvantage of increased density and difficulties at night should, however, keep this method in the category of an interesting experiment.



The "head first" method is much more practical.

So much for moving off. Now let's take a look at the second half of the problem.

Quite obviously the reason for over-speed during movement is caused by the tail attempting to catch up to normal intervals and thus avoid the possibility of getting separated. As it is impractical to use road control to the extent that the system is fool-proof, let alone idiot-proof, some means must be

found which will hold the convoy together. This was accomplished by establishing the principles that the leader must gauge his speed in terms of the slowest vehicle in his convoy and must hold that reduced speed until he is certain that the tail has cleared the defile, hill or other obstacle responsible for the slow-down. As in the starting procedure, he should then accelerate slowly to rated speed, and convoy drivers must be on the alert to alter speed accordingly. An easy way to assist the leader in selecting the proper speed is to place the slowest vehicle immediately behind him. Unfortunately, however, tactical considerations may rule against this, but there is no reason why it should not be done during administrative or approach moves.

In summing up, the main points to watch are:—

On Starting:

(a) Reduce the time lag on starting.

(b) Accelerate slowly.

(c) Hold half-speed for one minute for every ten convoy vehicles.

During the Move:

(a) Select the speed in terms of the slowest vehicle.

(b) Hold reduced speed till the tail is able to resume normal speed.

(c) Accelerate slowly.

These suggestions are, however, worthless unless the drivers are constantly on the alert to catch any acceleration or deceleration of the vehicles in front. It is most important, too, that drivers be taught to gauge distance with a reasonable degree of accuracy.

Tuli never had to leave garrisons behind him in occupation, for where he passed there was nothing left but uninhabited ruins. Of towns which had contained from 70,000 to 1,000,000 inhabitants nothing remained alive, neither a dog nor a cat...

—Michael Prawdin in the "Mongol Empire."

Invasion Without Laurels

PART 2

General Baron Leo Geyr von Schweppenburg.
Commander-in-Chief Panzergroup West.

Written by a senior commander of the German Armies in North-West Europe, this article presents the enemy view of the Allied invasion of Normandy. Copyright is reserved by the author. Permission to reprint the article in whole or in part must be obtained from the Editor of the Irish Defence Journal, through whose courtesy authority to publish it in the Australian Army Journal was obtained. —Editor.

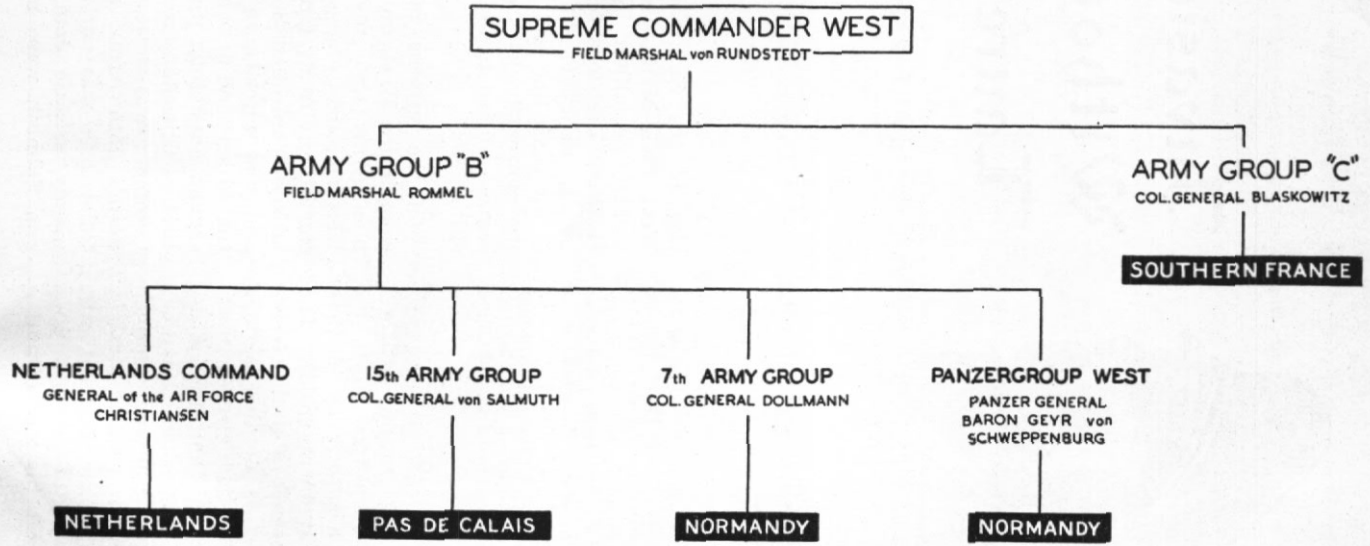
Part 2.

In the first part of this article I dealt with the background to the Allied invasion of France in 1944. Before the first enemy soldier had set foot on French soil the weaknesses and errors of the German High Command had already made it almost certain that the Allies would be victorious. Hitler's assumption of Supreme German Command, his "arm-chair" strategy (he never visited the Western battle areas), the type of advisers upon whom he leaned, the lack of authority of the Supreme Commander West, Field-Marshal von Rundstedt, and the resultant inability to get clear-cut decisions on controversial issues, Rommel's "linear" defence of the coast-line and refusal to hold the panzers back as operational reserves—all led to the inevitable result.

Of the various military formations in the West, only the 7th German Army and my Panzergroup were seriously engaged in opposing the Allies. Army Group "C" (Blaskowitz) controlled Southern France and was already in retreat when the Allied landings on the Mediterranean coast took place in August, 1944. Christiansen's Netherlands Command was static, while von Salmuth's 15th Army in the Pas de Calais area was not moved to Normandy because Jodl, Rommel and von Salmuth were all sure that a

ORGANIZATION OF GERMAN COMMAND IN THE WEST

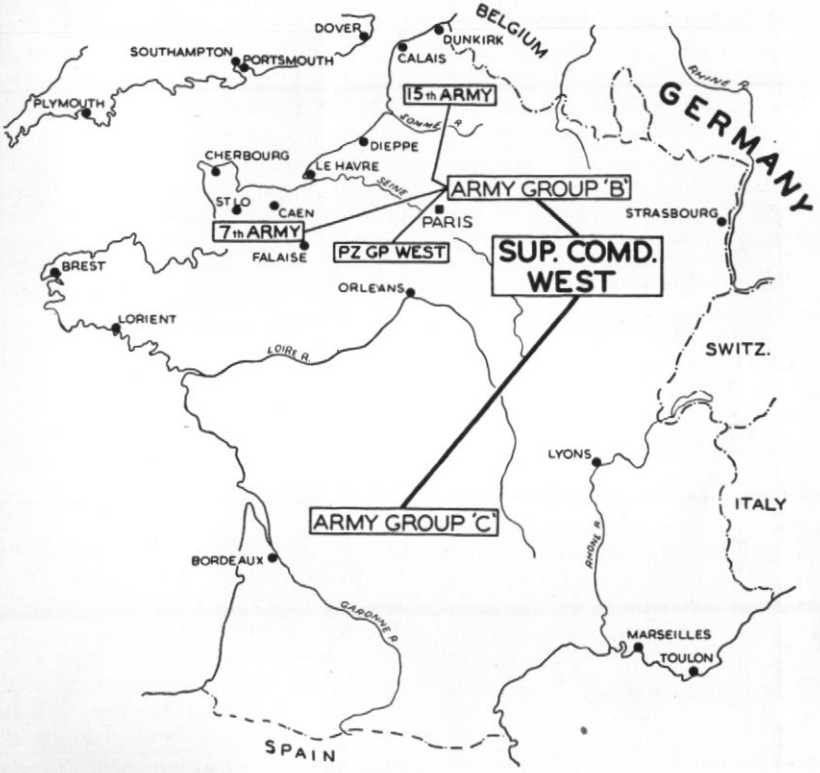
1944



Panzergroup West formed part of the 7th Army at the outset of the invasion. Later it became independent.

second Allied invasion would be mounted east of the Seine estuary. Not until a week after D-Day did parts of the 15th Army move westwards—and it was then too late!

As I pointed out in Part 1 of this article last month, neither the date nor the location of the Allied invasion surprised us. Normandy figured amongst the three possible invasion areas—the other two being Southern France and the Pas de Calais region. Early in the fighting it became clear to us (from captured enemy orders) that the Normandy assault was to be the only cross-Channel attack, although, as remarked earlier, neither Jodl, Hitler's Chief of Staff of the Armed Services, nor Rommel, the Commander-in-Chief of Army Group "B," would accept this obvious fact until it was too late to move the 15th German Army to the support of the 7th German Army in Normandy.



The Organization of "Supreme Command West" in France, 1944.

The first news I had of the Allied invasion was on the morning of 6 June, 1944. A short while later I learned that orders had been issued by Supreme Command West to move the panzer division Hitler jugend and soon afterwards Panzerlehr Division to the western end of the Allied beachhead. I appealed

to Field-Marshal von Runstedt at least to delay the second of these divisions until after nightfall, on account of the enemy's command of the air. Von Rundstedt did not comply with my request, and as a result the Panzerlehr Division lost some 123 trucks and the bulk of its armoured carriers during the march.

The initial moves of the panzer divisions were ordered without reference to me. Since Hitler himself had agreed to the retention of four panzer divisions as a mobile operational reserve, the order to push these units into the line meant that O.K.W. had gone back on this decision.

On 7 June, the day after the first Allied landings, I was ordered to take over the Caen sector on either side of the Orne River, my left boundary being in the neighbourhood of Tilly. By the time I reached Argentan it was clear that hostile air action had thoroughly and skilfully interrupted road communication by bombing such bottlenecks as villages, bridges and culverts, and detours were scarce and difficult to find. Furthermore, the military police available were quite insufficient to control the weight of traffic moving to and from the front.

As an additional complication, Panzergroup West was under the command of the 7th Army, so that direct contact between my staff and Rommel, the Army Group commander, was for the time being prohibited. Subsequently Pangergroup West was released from 7th Army control and became in effect an independent army.

The 21th Panzer Division, which was billetted in the neighbourhood of Caen on 6 June, was the first to go into action. Strong elements of the division lay close to the landing zones of the 6th British Airborne Division. Contrary to the teaching of Panzergroup West, which required immediate counter-assault against airborne landings in order to take advantage of the initial disorganisation of parachute and glider-borne troops, Field-Marshal Rommel had issued an order that the 21st Panzers were to move only on receipt of his personal instruction, and when the hostile attack began Rommel had left for Germany, so that the Panzer division remained inactive at the time when most advantage might be taken of the enemy weakness. The Chief of Staff of the 7th German Army made repeated requests that the panzer division be permitted to go into action, his first message being transmitted at 0215 hours on 6 June, but it was not until 0615 hours that the request was finally granted.

The staff of the 7th Army was one of the few clear-sighted and tactically sound staffs on the Western Front. It ordered the panzer division to attack the enemy along the eastern bank of the Orne only, but at the last moment this order was altered by the command of the infantry formation under which the 21st Panzer Division was placed, and the panzers, which had just made contact with the British airborne troops, were diverted to the western bank of the river, where, of course, they arrived too late to be effective.

By noon on 6 June the enemy had established a beach-head twenty-five kilometers wide and five kilometers deep between the Orne and the Vire. To the rear and left

of the 21st Panzers, the 12th SS (Hitlerjugend) Division was advancing on Caen and west of it. Further to the rear the Panzerlehr Division was concentrating for an attack north-east and north-west of Tilly-sur-Sueilles. By the time this division was ready to mount its attack on 8 June the enemy was reported to be in strength around Brouay, between Caen and Bayeux.

Pending the arrival of the staff of Panzergroup West 1 SS Corps, which meanwhile had arrived south of Caen, assumed command of the three panzer divisions in this sector. Had 1 SS Corps taken control of the situation at once it might have been possible to deal the British a severe blow in Courseuilles area. However, 1 SS Corps, instead of ignoring the succession of contradictory orders which emanated from the various superior headquarters, was unduly influenced by them, with the result that it missed the psychological moment and lost the chance of making a co-ordinated effort before the enemy had consolidated his beach-head. By 10 June such an attack by the panzers could not reap the rich reward which was to be had forty-eight hours earlier.

On the evening of 8 June my headquarters took over command of the sector from the east of the Orne westwards to Tilly exclusive. Having visited the units in action I reported by telephone to the Commander-in-Chief of the 7th Army, Colonel-General Dollman, that I was prepared to make an early attack and asked for a free hand to do so. Dollman agreed.

We were fully aware of the British landing methods, having studied the instructions captured after the unsuccessful Dieppe raid in 1942. There was no doubt that, so far, the enemy had been successful in establishing a large beach-head and that he had made good use of the three days' grace to build up and consolidate his initial gains. The Luftwaffe undertook no counter-offensives in daylight and its activities by night were of a very minor nature. The same must be said of the German navy, despite the propaganda which Goebbels was putting out. On our part, we were severely hampered by superior orders. O.K.W. clung to the idea that the Panzergroup, which was the strongest formation available in the West, was to be used to block the way to Paris. This was why, in the first instance, the panzer divisions were committed on the eastern flank of the Allied beach-head. Furthermore, there was a strict order from O.K.W. that no ground was to be yielded, even in mobile warfare. Needless to say, this prevented the mobile panzer divisions from being used effectively.

Accepting these limitations, especially the lack of air support, which meant that any panzer attack must be mounted under the cover of darkness, my chief idea was to attack the enemy in order to demonstrate that the panzers were still aggressive. This would compel the British to delay further advances and thus give us time to prepare subsequent blows. Owing to Allied air action against our depots and supply bases, ammunition and fuel were beginning to run short. However, I did not permit this to interrupt the attack. Having made a personal reconnaissance from the abbey north of Caen, I ordered the participating troops to

be ready for action north of Caen at nightfall on 10 June with a view to striking along and on either side of the narrow-gauge railway running northward from Caen. This terrain had been, in September, 1940, the training area for 24th Army Corps, which I had then commanded, in preparation for the invasion of England which never came off. (Operation "Sea Lion,,— See AAJ No. 8, Aug-Sep, 49).

While making my reconnaissance I witnessed part of a tank regiment of the 12th SS Division going into action. Soon after the tanks had left the cover of the western outskirts of Caen a large number of hostile bombers appeared and strafed the panzers. This was exactly what I had feared, and confirmed my opinion that without control of the air, panzers could only operate successfully by night.

The planned attack by the Panzergroup was not delivered. During the afternoon of 10 June exaggerated messages were received from Panzerlehr Division, stating that the enemy was attacking in force and that the front was broken, a large body of Allied tanks advancing in a south-easterly direction. Soon after this my command post was submitted to extremely heavy bombing and strafing which lasted a couple of hours. The entire operations section and most of the officers of the first echelon were killed in this air raid, and much of the material—transport, signal equipment and so forth—was knocked out, in spite of the fact that it had been widely dispersed. It seems probable that the Allies learned of our location through the local French Resistance organisation. Shortly after this disaster I received orders to hand over command of the Panzergroup to 1 SS Corps. The planned attack had to be called off.

When 1 SS Corps assumed command late on 10 June, the most threatened sector on Panzerlehr's front was south-east of Bayeux. After the enemy had taken this town on 7 June, American elements had pushed south-westward towards the Drome, so that a wedge was driven between 1 SS Corps and 11 Paratroop Corps. Army Group "B" planned to eliminate this threat with a combined attack from both flanks by 1 SS Corps and 11 Paratroop Corps. This idea, which had been a reasonable one, was dropped, however, and 11 Paratroop Corps was diverted towards the coast at Isigny, in the centre of the American beach-head.

It was natural immediately after the Allied landing operations that the German counter-efforts should be of a purely tactical nature. However, in order to regain the initiative it would be necessary for us to undertake an operational counter-offensive. By 12 June such measures were due to be taken. However, examining the orders issued by the various superior headquarters between 10 and 12 June, one is forced to the conclusion that the German command simultaneously pursued no less than four distinct aims, each of a defensive nature. These were:—

To prevent a hostile advance in the Caen sector;

To prevent a hostile advance in the Bayeux sector;

To eliminate the enemy bridge-heads on each side of the Vire;

To prevent the Cotentin peninsula from being cut off and a drive towards Cherbourg being mounted.

According to the von Schlieffen school of thought, the course to be adopted would have been to attack Bayeux and the region north of it with all available panzer forces on 13 June, all units being under a single command. It was by such concentration of forces that the Red Armies were defeated by us in 1941 and 1942. But the "arm-chair" strategy of Berchtesgaden, and Rommel's lack of strategic training, resulted in the panzer divisions being frittered away in piecemeal operations of a minor and defensive nature. In the meanwhile, orders and estimates varied almost hourly.

With a delay of between six and ten days after the initial landing of the Allies two further divisions were coming piecemeal into the sector of Panzergroup West. These were the Liebstandarte (Hitler's bodyguard), which came from Western Belgium, and the 2nd Panzer Division, which came from the Amiens area. Both were armoured formations.

Before the invasion Field-Marshal Rundstedt had promised — on my instigation — that the panzer divisions were to be committed as units and not piecemeal by companies and regiments. He had even embodied this is one of his numerous orders. In the event, however, the exact reverse took place; since "the line had to be held" elements of the panzer divisions were thrown into battle without regard to the tactical unity of the divisions.

In what we some times called the "pre-corporal" days—that is, before Hitler and his cronies began to conduct the war with complete disregard of the trained military experts —we would not have been unduly worried by the situation in the front line becoming apparently critical. We should have waited unperturbed until all the reserve divisions involved had assembled and should then have launched them in a counter-blow against the enemy.

Under the regime now in vogue, however, this method was not possible. Neither Hitler, nor Supreme Command West understood — nor had the courage to — let "panzer situations" ripen.

Sepp Dietrich, the commander of 1 SS Corps, who had direct contact with Himmler, wanted to keep both the original divisions of his corps, Hitlerjugend and Liebstandarte, within the corps. The 2nd Panzer Division (an Army, not an SS unit) was held back by Rommel for some time, because, in expectation of the "20 July Plot" to assassinate Hitler, he wished to have a "reliable" Army division available for any emergency. Although the situation at the front obliged him to commit the 2nd Panzers on the western sector of the battlefield, where it opposed the 1st US Division, Rommel did manage to keep the 116th Panzer Division in reserve until the middle of July.

These two extraneous factors, which had nothing to do with the conduct of the battle, interfered with the tactical handling of the situation in Normandy.

In the meantime, further to the west, the first-rate 2nd SS Division (Das Reich) and the Panzergrenadier Division Goetz von Berlichingen were hurried from the south of

the Loire and committed in support of the infantry formations in the St. Lo area, the tanks being employed partly as defensive pillboxes.

Because of the system of committing the sub-units of these divisions piecemeal as they arrived at the front, the grenadier (viz., armoured infantry) regiments were already exhausted and reduced in combat strength when their divisional tank regiments came up, the latter being, of course, slower to arrive.

To sum up the foregoing, the panzer divisions could not have been frittered away and committed to battle with less understanding.

From 10 to 20 June the Allies undertook no major operations against us. Indeed, we were not surprised that there should be a pause for reorganisation, since by tradition the British soldier is slow and cautious rather than daring in his manner of waging war. As a tactician, Field-Marshal Montgomery was particularly cautions, relying always upon superiority of material rather than upon brilliant manoeuvre. This was exactly what I had expected. On the other hand it should not be thought that the British troops were not exceedingly brave. The Canadians were especially courageous. Both the British and Canadians reacted in battle just as we had anticipated, but the Americans had been rather a mystery to us. It was impossible to forecast just how they would acquit themselves in action.

The only British armoured division to prove a serious nuisance to us at this period was the 7th—the famous "Desert Rats." The troopers were experienced desert fighters and understood tank warfare thoroughly. Incidentally, this division had been my host in Heliopolis, during a visit I paid in 1937, when I spent several very enjoyable hours in the mess.

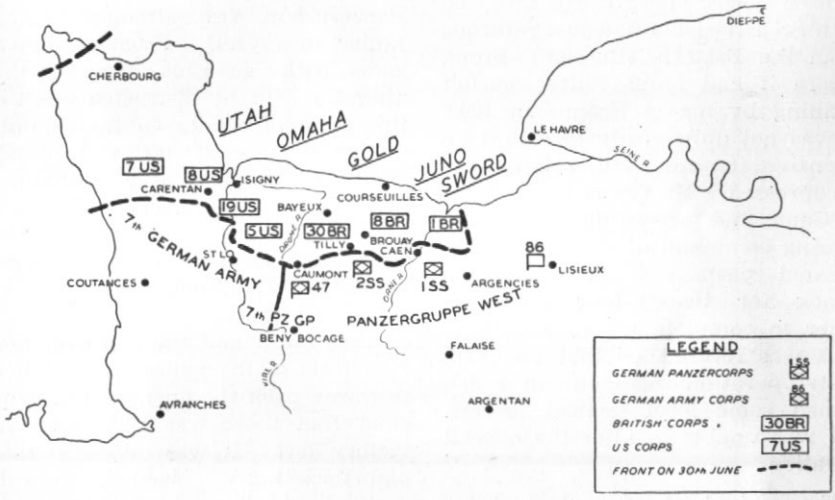
As regards British armoured tactics, I personally favour the method adopted by Montgomery in preference to that recommended by General Martel, the Director of British Royal Armoured Corps until 1942. Martel's belief in the dual functions of tanks and the resultant necessity for two types—the "Infantry" and the "Cruiser" tank—is doctrinaire rather than practical. In action it is rarely possible to have available both types of unit so that either may be committed according to the demands of the situation. We Germans have a basic military axiom which is undoubtedly a sound one: "Im Krige hat nur Eintaches Erfolg." ("In war, only simple solutions will prove successful.")

In my opinion, the formation which breaks through the hostile defences should be employed in exploiting the break-through. There is little enough time during which one may take advantage of a local defeat of the enemy, and if leapfrogging is attempted the psychological moment may be missed. This time-losing method of leap-frogging formations through one another was employed by the peace-time British Army in the 'Thirties, and to my mind it was not successful in combat. Speed is of first importance in armoured warfare.

The Russians, of whom I had some experience during the years 1941 and 1942, serving both with Guderian during his rapid armoured march on Moscow and with von Kleist during the Stalingrad-Kuban-

Caucasus offensive in the following year, are inclined to be doctrinaire like the British. On the other hand, the Americans do not seem ot have allowed theory to master the practical, which is, after all, the sanest outlook.

During the respite allowed us by the slight lull in Allied operations, we rushed reserves up to the front. From Bayeux the British continued to press towards the south-east, while the Americans established



The Normandy Battle Area on 30 June, 1944.

It had been delayed by the fact that almost no radio equipment was available, as the radio factories in Germany had suffered severely from enemy air action.

By 23 June the menacing situation at Cherbourg, together with the fact that the enemy had been reinforced by at least half a dozen divisions, was appreciated by the 7th German Army, and it was recognised by the Army Staff that the next Allied push would be west of the Vire. Two

themselves in the Caumont area. About this time the Command of the 7th German Army once again emphasised that the panzer forces were not being employed as they should be, and proposed to Army Group "B" that 1 and 11 SS Corps and 47 Panzer Corps, together with 86 Army Corps, be united in Panzergroup West's control. This proposal was a sound one for it was still not too late. The reforming of my staff was now almost completed.

courses lay open to us. The first was to mount a powerful panzer attack—employing the newly received "Tiger" tank battalions—in the Bayeux region. The second was to transfer the panzer forces westward to the Cotentin peninsula and throw them against the Americans there before the fall of Cherbourg should release the formations employed in reducing the great port. But nothing of this kind happened. Rommel had lost all faith in the

ability of panzer units to move in face of enemy air superiority. Influenced by his experience in the open North African desert, he did not allow for the fact that there was all the difference in the world between Libya and the well-covered Normandy terrain. So the piecemeal operations went on.

On the 28 June the reconstituted Panzergroup West took over control of the troops in the area between the Seine and the Drome; 1 and 11 SS Corps, 86 Army Corps and 47 Panzer Corps, 11 SS Corps (9th and 10th SS Divisions) had just returned from the Eastern (Russian) Front, where it had fought after earlier training by me in France in 1943. It was not quite ready to mount an offensive in order to relieve the hardpressed 1 SS Corps to the west of Caen, and, accordingly, upon resuming command of the sector I requested permission to delay the attack for twenty-four hours in order to complete the preperations. This was refused, so that an overhasty operation was mounted which gained some local tactical success, but was unable to alter the overall situation.

The arrival of a number of infantry divisions presented us with an opportunity to withdraw three panzer divisions from the line and assemble them under the command of 1 SS Corps as mobile reserves. This was suggested to Rommel. Although his Chief of Staff concurred with the proposal, Rommel himself firmly declined. "The infantry is not able to undertake the task and will not undertake it," was his reply.

His refusal may have had a political reason. It could not be expected that shortly before the 20 July, on which day Hitler was to be eliminated, Rommel (who was a party to the plot) would have been eager to place three divisions under the command of 1 SS Corps, which was likely to remain loyal to Hitler and might accordingly be a direct threat to himself.

At noon on 28 June Colonel-General Dollman, Commander-in-Chief of the 7th Army died. The Commanding General of 11 SS Corps, General Hausser, an able and extremely brave officer, took over the command of the 7th Army, together with Panzergroup West, although he was junior to myself. From Berchtesgaden Hitler gave his consent to this alteration, for he distrusted me, but this state of affairs continued only during the absence of von Rundstedt and Rommel at a conference at Hitler's headquarters.

The 2nd British Army continued to extend its front south-west of Caen. Since the situation was becoming more and more grave, and all efforts of the panzer units failed to throw back the enemy, it became clear that there was little hope of victory left. It was obvious that plain speaking was needed. Accordingly, I submitted the following report to O.K.W. through the usual channels of command:—

> "The estimate of the situation must be faced up to realistically. To drive the enemy back into the sea is out of the question. He has formed a strong front of considerable depth, and has reserves available. After the surrender of Cherbourg further hostile divisions will be freed. The German panzer divisions are being bled white in purely defensive positions under the fire concentrations of enemy ship-borne artillery.

"It is of primary importance to keep the panzer formations 'in being' for offensive employment in the future. This can be brought about and success ensured by straightening the front . . .

". . . It is therefore proposed to abandon the northern part of Caen, to withdraw the front line behind the Orne River, and to occupy a line of defended localities across the Caumont. This will permit the withdrawal of two and a half panzer divisions for rest and later offensive action (half of 21st Panzers, Hitlerjugend and the panzer training division).

"This ought to be done immediately in order to benefit from the alteration.

"Experience on the Eastern (Russian) front teaches the lesson of clinging to bridgeheads."

Field-Marshals Rommel and von Rundstedt both agreed.

The result of this report was instantaneous. Von Rundstedt and I were immediately relieved of our appointment by Hitler. Telling us of this development, Rommel announced, "I will be next."[1] On the evening of 5 July I handed over command of the Panzergroup to my successor, General Eberbach.

In the foregoing account of the Normandy battles I have been extremely critical of the higher German command, especially of Field-Marshal Rommel and of O.K.W. headed by Hitler and his adviser Jodl. I believed from the first that "Cordon defence" of the coasts was not practicable for a number of reasons, and that the only method of defeating the invaders was to allow them to penetrate deep into France, where they would be beyond the support of their naval guns and close-support aircraft based upon Britain, so that our panzers, held in operational reserve, could make full use of their superior mobility and leadership in order to strike the lengthy Allied communications and destroy their ground forces on a battlefield of our own choosing. For this reason I had wrung from Jodl the promise that at least four panzer divisions would be held back for this purpose, but, within a few hours of the Allied landing, this promise was forgotten and my units were thrown piecemeal into the battle of the beachheads.

In my view, it was necessary for us to undertake a strategic defence —which in practice would involve tactical offensives at the most advantageous moments for ourselves. Mere linear defence, no matter how strong the "line," was worse than useless. For a strategic defence the manoeuvre area was to be the whole of France. Therefore I wished to hold no less than seven panzer divisions in operational reserve in two groups, one in the wooded area north of Alencon, the other south of Paris. The "Atlantic Wall" would be held by covering forces only. The line of the Meuse should be secretly prepared for defence, in case it should be necessary for us to abandon France even temporarily. Then as the hostile columns pressed into France the operational reserves, located as stated, could move by night (so as to minimise the risk of aerial strafing) and launch swift assaults upon the enemy forces, breaking off the action at will and repeating the attacks again later. The retention of mere terrain was meaningless. If

1. He was right. Rommel's punishment, however, was more serious than mere dismissal. He was "liquidated" for his part in the '20 July Plot."—Editor.

we lost Caen, Paris or anywhere else for the time being, these would automatically be regained when the enemy was defeated. As our panzer forces were more experiencd and better trained than the Allied armoured units, and as our "Panther" and "Tiger" tanks far outmatched anything the Allies had produced, we must inevitably be superior in mobile warfare.

For our petty Air Force I proposed only one task—the Luftwaffe should be systematically hoarded until the moment of the "retour offensif" of the panzers, and then employed to cover the battle area for just twenty-four hours.

Whether my scheme was sound or not, it was obviously quite illogical for von Rundstedt to order us to train the panzers for mobile operations and then for Rommel to employ them in linear defence.

The "bocage" country of Normandy, broken into innumerable fields surrounded by impenetrable hedgerows, was in no way adapted for tank action. Undoubtedly, Rommel alone cannot be blamed for the employment of the panzers in this disastrous fashion, but he opposed Guderian's advice and never made any real effort to convince Hitler that he was wrong in demanding that not an inch of ground be given up to the enemy. At St. Lo, Rommel admitted to an army corps commander: "I know you are right and I agree, but the Fuhrer will not stand for such a move." This remark is extremely revealing, showing not only the extent of Hitler's intervention in operational matters, but also the moral weakness of the Army Group Commander-in-Chief.

It may seem strange, in view of the subsequent break-through of Patton's 3rd US Army west of St. Lo, that Panzergroup West should have been entirely committed on the eastern sector—which was in fact the "inner" wing.— This was due in part to the fact that the first panzer units to be sent into action against the Allies on D-Day were in this sector, but more especially it was because Hitler insisted that the route from Normandy to Paris must be covered by the strongest forces available.

In the time of Henry IV Paris may have been "worth a Mass," but in 1944 it was certainly not worth so gross a strategic error. It was not just a choice between the loss of Paris and the loss of Brittany, for the loss of Brittany meant the loss of the entire position in France, and Paris with it.

The normal and correct emloyment of armoured cavalry is on the outer flank, and it was there that the Panzergroup should have been committed. This is clear to every cavalry commander and is not wisdom after the event. But not one of those who held a senior command in France in 1944 or who had any influence with the leaders was a cavalryman, "brought up on mare's milk."

When the fall of Cherbourg was imminent, I insisted in person to General Blumentritt, von Rundstedt's Chief of Staff, at Western Supreme Command Headquarters at St. Germain, that "Feint Operation Westhoven" should be launched.

The plan for this operation originated from the British General Allenby's famous "feint operation" in Palestine in 1918. I wanted to give

the British a dose of their own medicine.

The plan was roughly as follows. Since it seemed impossible to move the panzer divisions away from the inner flank — obviously the wrong place for them—I suggested that all the reconnaissance groups of the different panzer divisions should be transferred to the outer (western) flank and committed under the command of the able General Westhoven, so as to give the Allies the impression that the bulk of the armoured divisions was about to follow suit. This, I believed, would have serious repercussions on the Allied side, causing them to reorganise and alter their operational plans. However, Blumentritt did not appreciate the value of my proposal and nothing was done about it.[2]

In conclusion, I will quote a letter sent to me on 20 July by Panzer-General Eberbach, who succeeded me to the command on 5 July. He wrote:—

"Dear Herr von Geyr,

"Everything is taking place as you forecast. We are all thinking of you. I have no doubt that you are lucky to have been spared the outcome of the struggle here. However, I shall do my best to command in the same fashion that you did.

"During the last attack the British dropped 7,800 tons of bombs. It was hell. But our troops behaved very well.

"It was difficult to halt the advance of 800 British tanks, even though we knocked out 200 of them. Our losses have been so heavy, including losses of material, that another attack might be hard to stop, unless the British are generous enough to delay their next offensive for a time . ."

General Eberbach was undoubtedly right, and I was indeed lucky to have been dismissed early in July. The fate of the German forces in France was sealed by the failure of the higher commands in the early stages of the struggle.

2. For the record it should be stated that, in August, 1944, after General Patton's US Third Army had broken through on the western (outer) flank and initiated the encirclement of the Germans in the Falaise pocket, the panzer divisions were belatedly moved as General von Geyr had suggested. In the German counter-attack at Mortain, which aimed at reaching the sea near Avranches, and thus cutting off Patton's Third Army from the US First Army in Normandy, the German Command committed 1 and 11 SS Corps, the 2nd and 116th Panzer Divisions and elements of the 17th Panzer Division, as well as infantry formations. But the move was made too late.—Editor.

[In a letter to the Editor, discussing the publication of these articles, General von Geyr said that recently he had met Rommel's personal orderly officer, who told him that Rommel had expressed the following opinion in July, 1944: 'After all it might have been better to defend strong points only along the coast and to have kept back the panzer divisions in reserve."

General von Geyr suggested that this note might be added in the interests of historical truth and not as a mere justification of his own opinions as expressed in these articles.—Editor.]

The Story of Blood

Condensed from a Pamphlet issued by
The Australian Red Cross Society.

SINCE the days of antiquity mention of blood has always made a deep impression on people. The Jewish historian Josephus mentions blood repeatedly, and the Scriptures contain more than three hundred references in one sense or another — spiritual, hereditary, or physiological. Frequent allusions to blood in the literatures of many nations through their recorded history are attributable to its dramatic implications. Little was known about the composition or function of blood until such discoveries as its circulation by Harvey in 1628 and its four main groups by Landsteiner in 1901. Usually the sight of blood or the loss of blood has been associated with tragedy and death. Now, in the light of modern knowledge, as blood is used by physicians to alleviate human suffering, it is expected that this traditional attitude will disappear and that this magic fluid will be considered an instrument for saving human life.

In peace and war the provision of blood transfusions is an important part of the treatment of the sick and wounded. Soldiers should appreciate that this operation is now so well understood and thoroughly organized by the Medical Service that it should be regarded as a normal step in the treatment of injured persons and not, as is popularly supposed, a last desperate attempt to save the patient's life. It is hoped that the following description of the composition and function of blood will help to remove the fear and mystery from what is a perfectly simple operation.

What Does Blood Do?

Blood, which the heart pumps rapidly round and round the body through miles of blood vessels, does many things to keep us alive and healthy. It carries the necessities of life—oxygen, water and food—to all the cells of the body.

Blood helps the cells of the body to breathe by bringing them oxygen from the lungs and by taking carbon dioxide from the cells back to the lungs, where it is expelled.

It carries food from the intestines to the cells and carries waste products to places where they are removed from the body. It also furnishes water to the cell tissues.

It distributes heat produced by the working muscles; blood serves as a temperature regulator for the body.

In addition to all these jobs, blood, by the action of its white cells, antibodies and certain complex

chemical substances, serves as a constant bodyguard against infections and other diseases.

Blood does these things for us in its normal course through our bodies. In addition, as we shall see later, our donations of this magic fluid may help to save the lives of others.

What are the Parts of Blood, and How Do They Work?

The microscope shows that blood contains cells suspended in a liquid. These cells—red cells, white cells, and platelets — comprise about 45 per cent. of the blood. The remaining liquid portion is the plasma, about nine-tenths of which is water.

Red cells look like red discs or saucers with pale centres. They are usually all about the same size.

White cells are ordinarily larger than red cells and have well-formed centres, or nuclei, the essential part of the cell.

Platelets are colourless cells with no nuclei, varying in size and shape.

Plasma, when separated from the cells, is a pale yellow fluid.

Red Cells.

Physicians believe that in general red cells are made in the red bone marrow. The raw materials needed to build these cells are stored in the body.

At a certain point in the development of the red cell, haemoglobin is added. This haemoglobin consists of the iron-containing red pigment (haeme) combined with a protein substance (globin). It is the haemoglobin which gives the red cells their ability to pick up oxygen in the lungs.

Iron is a keystone raw material required by the red cell factories. Part of this is "scrap iron" salvaged from broken-down red cells; the rest comes from food. It is necessary to have enough iron in the body to keep the production of haemoglobin up to the normal rate. If iron is lacking, the amount of haemoglobin in the red cells is lowered, and later the number of red cells in the blood is reduced. The best food sources of iron are meat (especially liver), eggs, green leaf vegetables, and whole-grain bread and cereals.

Within the body, red cells have been found to live about 100 to 120 days, but some cells last as long as 140 days. The rugged conditions under which the fragile red cell lives are the reason for its short life span. This delicate structure has to withstand constant knocking around as it is pumped into the arteries by the heart. Travelling through blood vessels at high speeds, bumping into other cells, bouncing off the walls of the arteries and veins, squeezing through narrow passages and adjusting to continued changes in pressure, all tend to exhaust the red cell. As it gets older, its resistance to such abuse is reduced, and the cell breaks into pieces. Fragments of red cells, some only dust-like particles, are found in the blood, the spleen, and sometimes in other body tissues. Old or dead cells are removed from the blood by the spleen, which in this capacity is considered a "graveyard."

Red cells also provide the body with a motor transportation system. After picking up oxygen in the lungs, red cells deliver it to the tissues, where it is used. Ordinarily, only one-fifth to one-fourth of the oxygen load is released, as the tis-

sues are not able to absorb more than they need at the moment. The rest of the oxygen remains in the haemoglobin as an emergency reserve supply.

The average man has thirty trillion red cells (30,000,000,000,000) in his blood, about two and one-half trillion per pint. Women have slightly fewer red cells.

White Cells.

Research has shown that white cells are probably made in the bone-marrow and in certain lymphoid tistues of the body. There is only one white cell to every 600 red cells. These white cells are among the most important agents by which the body defends itself against disease.

Their ability to move and to engulf solid particles gives them a weapon with which to attack bacteria. Since white cells are able to reach almost any part of the body, they travel about from place to place as they are needed. By squeezing through crevices in the walls of the capillaries (the smallest blood vessels), white cells are able to move out of a blood vessel, and great numbers of cells can, in this way, leave the blood in a short span of time and reach the place of injury or infection. White cells can be thought of as a defending army, with various corps having their own specialties. When the body is attacked by an invading disease, the white cells close in. One group, the neutrophils, "fights" the bacteria by "eating" them. As many as 20 or more bacteria have been found inside one attacking white cell. Another group, the lymphocytes, discharge anti-toxins that poison the invading bacteria; other anti-toxins remain for a while to protect the body from a counter-attack.

There are times when the existing white cells are inadequate to hold back the progress of the disease, and additional forces are needed. When the cell-forming organs of the body get the "alarm' from those white cells already fighting, the emergency is met by releasing available reserves into the blood. If the condition is critical, even very young cells can also be released as a last resort to help fight the disease.

Platelets.

Platelets are probably made in the giant cells of the red bone marrow. There are about one and one-half trillion platelets in the normal average body, and after a short life of only three or four days, they are removed from the blood by the spleen, lymph nodes, and liver.

Platelets assist in blood coagulation since they help form the blood clot, which in turn stops bleeding by plugging openings in the blood vessels.

Plasma.

Plasma is composed of water (about 91-92 per cent.), proteins (about 7 per cent.), and very small amounts of fats, sugar and mineral salts. The sticky or gummy quality of blood that is necessary for maintaining normal blood pressure is partly caused by the plasma proteins. Without certain proteins blood would not clot, and it is by clotting that bleeding is stopped.

Although the parts of blood have been discussed separately, the work of all parts is carried on simultaneously and in a co-ordinated manner. For example, at the same time that white cells are attacking in-

jurious bacteria, the antibodies of the plasma proteins are also helping to protect the body by counteracting the effects of the invaders.

How Much Blood Have You?

The normal human adult of average weight has approximately 12 to 13 pints of blood in his body.

Under certain conditions, when the supply of oxygen to the tissues is low, the blood volume may be increased. These conditions include exposure to high temperature, high altitude, muscular exercise, emotional excitement and pregnancy. A reduction in blood volume below its normal level may be caused by haemorrhage, a decrease in the total number of red cells, the loss of plasma caused by extensive burns, or the loss of water from the blood.

What is Your Blood Group?

There are four main groups of blood—A, B, AB and O. In addition, subgroups of these main groups have been found.

When a person requires a whole blood transfusion, he must have blood which matches his group. Therefore, group A blood is given to group A patients, group B blood to group B patients, and so forth. Giving group A blood to a group B patient causes the cells to clump, with possible fatal results; however, under certain conditions group O blood may be given to group A, B or AB patients.

To make sure that the blood to be given to a patient "agrees" with his blood, samples of each are first cross-matched. If the cells from the donor's sample do not clump when added to the blood serum of the patient's sample, and vice versa, the bloods are "compatible," and successful transfusion is possible.

What is the Rh Factor?

Although the four major blood groups were recognised as early as 1901, this knowledge did not eliminate entirely the severe and even fatal reactions which followed a blood transfusion. Moreover, doctors were frequently at a loss to explain numbers of stillbirths and the often fatal jaundice developing in newborn infants. It was noted, however, that these tragedies most frequently occurred where the mothers had had difficulty in previous confinements or had received a blood transfusion. The explanation of the obstetrical disasters and the atypical transfusion reactions remained obscure until the discovery in 1940 of another blood characteristic, one entirely distinguishable from the major blood groups. Because it was recognised first in rhesus monkeys, it was called the "Rh factor." The 85 per cent. of the human white race who have this blood characteristic are called "Rh positive" and the remaining 15 per cent. who lack it, "Rh negative." The Rh positiveness or negativeness of any individual is determined by inheritance in the same way as colour of the skin, eyes, hair, etc., and does not change throughout life.

The Rh factor is of importance in transfusion and in pregnancy, because the entry of Rh positive blood into the circulation of Rh negative persons may cause the production of antibodies. When this occurs, we say that the Rh negative person has been "sensitised to the Rh factor." Although these antibodies are actually a defence and cause no reaction in the sensitised person, we

shall see that their presence is a potential danger.

There are two ways by which Rh sensitisation may be brought about.

First, by transfusion of an Rh negative person with Rh positive blood; a large proportion of such persons will become sensitised, and produce antibodies. A subsequent transfusion of Rh positive blood may result in a serious, if not fatal, transfusion reaction as the Rh positive cells meet the Rh antibodies and are destroyed.

Second, by pregnancy. Fortunately, this does not happen in all cases, but in only approximately one of every one hundred and fifty pregnancies, and least often in a woman's first pregnancy. The marriage of an Rh negative woman to an Rh positive man may result in an Rh positive child. Before birth, the infant's Rh positive red blood cells may enter the mother's circulation, causing her to be sensitised, The antibodies thus formed in the mother then return to the infant and cause destruction of its blood cells. This will result in anaemia, jaundice, or even still-birth.

It is important that all pregnant women be tested to determine whether or not there may be impending damage to the infant, so that appropriate measures may be taken. In these ways, the hazards of the Rh factor may be reduced to a minimum.

What Are Some Common Diseases of the Blood?

Anaemia.—Diseases affecting the red cell population may be characterized by a condition called anaemia. A person may have anaemia if the output of his red cell factories is deficient in quantity or quality or both; or if the number of red cells destroyed or lost from his circulation (as in haemorrhage, for example) is greater than usual.

Iron-Deficiency.—This is the cause of one group of anaemia. A person suffering from an iron-deficiency anaemia looks pale and may feel tired all the time, partly because his red cells are smaller than normal and partly because each red cell has received less than its normal quota of pigment. The iron-deficiency may result from a lack of enough iron in the diet or from defective absorption of iron from food.

Pernicious Anaemia. — A most serious form of anaemia is pernicious anaemia. This is a chronic, progressive disease involving the blood and the blood-forming organs. Physicians can now control it by giving the patient liver extract that contains a factor necessary for the manufacture of red cells.

Laboratory examination of a sample of blood is the only sure way of telling whether a person is anaemic, and if so which of the many forms of anaemia is present.

Leukemia.—An increase in white cells under the stimulus of an infection is an orderly mobilisation set in motion by the body's need for new recruits to fight invading bacteria. When there is a wild disorderly overgrowth of white cells, leukemia is the result. Leukemia is a malignant blood disease for which there is as yet no cure.

Haemophilia. — Persons whose blood does not clot normally ("bleeders") may be suffering from an hereditary disease called heamo-

philia. In haemophilia, one or more of the factors which take part in the drama of clotting may be abnormal or missing.

What is Shock?

Shock is the body's reaction to injury. In mild shock resulting from slight wounds or surgical operations, the effects on the circulation do not last very long, and usually no treatment other than rest is necessary.

In severe shock, in which there is a marked loss of blood volume, the effects on the body are serious and complex. The loss of fluid begins when damage to the tiny blood vessels around the injury allows plasma and some blood cells to escape into the tissues. Less blood is then returned to the heart, and hence less blood is delivered to the spleen, liver and other parts of the body. Circulation is slowed, thus causing a radical drop in the amount of oxygen delivered to the tissues. The less oxygen the tissues get, the more fluid leaks out of the blood vessels and the viscosity of the blood increases, causing further slowing of the circulation. Thus a vicious cycle is started which is difficult to stop; after shock reaches a certain stage and the brain too is affected, the process cannot be reversed.

Shock is best treated by prevention. If the lost blood volume is quickly replaced, the tissues will not lack needed oxygen and the serious shock cycle will not begin. By blood pressure and pulse reading, the physician can tell the state of the shock cycle. Also the general appearance of the patient, his cold white skin, restlessness and thirst, indicate that shock is impending or is in progress.

What Are Some Medical Uses of Blood?

Whole Blood.—The term "whole blood" is used here to denote fresh blood to which a preservative has been added. This preservative is usually a solution containing citric acid, sodium citrate and dextrose—an ACD solution. Whole blood must be stored in refrigerators at a temperature level of from 4 to 6 degrees Centigrade; under these conditions it may be kept for about 21 days.

Whole blood transfusions are necessary whenever large amounts of blood have been lost as a result of an accident, injury, childbirth, or certain diseases. Whole blood may also be used for the treatment of infections, haemorrhagic diseases and chronic anaemia.

Plasma.—Plasma, the liquid portion of blood, is separated from the red cells by means of a milk separator. The heavier, cellular elements of the blood come out by the milk outlet, whilst the lighter plasma is collected from the cream outlet. The plasma is then clotted to convert it to serum, and the serum is fitered to remove any bacteria that may have entered during the process. It is then bottled and is ready for use.

Serum is sometimes used in the treatment of burns to replace the fluid lost from the blood. Because of its relative simplicity of storage and administration, it is used for emergency cases, such as accident victims, and in remote areas where facilities for administering whole blood are not available.

Fractions. — Plasma has been broken down into fractions by a process known as selective precipi-

tation. As a result of mixing plasma with certain chemicals, the proteins can be separated individually as pastes. These pastes are quickly frozen, then dried. The proteins appear as dry white powders, and in this form are stable and easily stored. Later they are dissolved, sterilised and packaged.

Many fractions have been isolated, and from these several derivatives are now available for medical use; as research continues, more will be available.

This complicated and highly technical process has not been undertaken in Australia, and we have been dependent on supplies from England or America, but plans are at present in hand, and it is hoped that it will be possible in the near future for us to produce our own fractions.

Serum albumin, about half the protein content of plasma, is used in the treatment of certain kidney and liver diseases and for the emergency replacement of lost blood volume.

Immune Serum Globulin is used for the modification or prevention of measles. Measles, although a common childhood disease, is sometimes dangerous in that it may result in complications such as injury to the eyes, ears, lungs and heart.

Antihaemophilic globulin is used to control bleeding when it is the result of haemophilia. By injecting the patient with this globulin, the abnormal time required for the clotting of his blood is temporarily reduced.

Blood Grouping Globulin.—This is used to determine the blood groups and Rh factor. This fraction may become increasingly important because it is essential to have a reliable agent for grouping blood.

Fibrinogen and Thrombin.—Two plasma proteins are essential to blood clotting. By combining them, fibrin film and fibrin foam are produced. Fibrin film is a cellophane-like sheet which can be used to repair tissues in brain and nerve surgery. Fibrin foam is a sponge-like product used to stop bleeding from surgical or accidental wounds.

In addition to the fractions, red cells also are used. The solids that are separated from the plasma by centrifuging are a mixture of red cells, white, cells and platelets. However, since there are about 20 times as many red cells as white cells and platelets combined, and because the mixture is used for its red cell content, it is generally referred to as "red cells." Red cell suspensions are used to treat certain anaemic conditions in which there is no need for additional plasma in the blood, and red cell paste and powder have been used to promote the healing of certain wounds.

NAVIGATIONAL AIDS

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Introduction.

It is clearly of some importance that units of the Army should be able to find their way from one place to another rapidly and without getting lost.

The Army in company with the Navy and Air Force have used magnetic compasses for finding the way about for some years and continue to do so, but various other aids to navigation have been developed, particularly to satisfy the demand for means to "fix" position. These newer aids have not, so far, been used by the Army, and it is the purpose of this article to try to explain the principles they employ.

Of course various methods of obtaining a "fix" have been available for years, for example astro, solar or lunar observations or measurements of the bearings of recognisable objects of known position on the ground. The first group is not in normal use in the Army because delicate and accurate instruments are required which are quite unsuitable for general use. The second is the normal method used in the Army, and is so familiar that no explanation is required here. However, the technique of obtaining a "fix" by the method of back bearings is illustrated in Figure 1, because the geometry is the same whether the bearings are measured by radio or the more familiar prismatic compass.

The magnetic compass is not without its limitations. In some areas there may be local variations due to magnetic ores in the ground, and such variations can be allowed for only by making a very detailed survey of the area. A compass used in or near a vehicle or other mass of magnetic material is liable to error unless special precautions are taken. Tanks are particularly difficult in this respect. Lastly it is to be noted, in view of the emphasis placed these days on arctic warfare, that at the magnetic poles magnetic compasses cease to function.

Dead Reckoning and Course Plotters.

A simple and much used method for estimating position is that known as dead reckoning. Assuming that the starting point is known and that the direction of travel and distance traversed can be measured, the course is plotted on a map. Thus a vehicle might, by magnetic compass and speedometer, know that it travelled 30 miles east and then 40 miles north, and by plotting discover that it is now 50 miles on a bearing of 37 deg. from the starting point.

An instrument called an odograph is available in the USA to do the

plotting automatically. Distance is taken from the wheels of a vehicle, direction from a magnetic compass, and with the aid of servo mechanisms, a continuous plot of course is obtained in the form of a line drawn on a map. The device is suitable for mounting in a jeep. An experimental model of a similar instrument has been made in Australia, this time mounted in a special jeep trailer.

An accuracy of better than ½ per cent. is claimed for the adograph, provided that the instrument is checked every day for current compensation for the magnetic effect of the vehicle carrying it.

Dead reckoning and course plotters are of course useless if the starting point is not known, so that once "lost" they are of no help, except perhaps to prevent travelling in circles.

Radio Direction Finding.

Radio direction finding was the earliest form of radio navigational aid to be used. It depends upon the fact that it is possible to make an aerial system which has directional properties and can be used either as a homing device or to obtain position. The latter use for obtaining a fix will be explained in terms of a vehicle equipped with a suitable directional aerial.

The vehicle receives radio transmissions from two stations whose positions are known; the transmissions must of course be identifiable by call signs or some other means. Using the directional aerial, the vehicle determines the directions from which the signals are being received relative to the heading of the vehicle. Now if the heading of the vehicle is known, say by magnetic compass, the directions of the signals relative to north can be worked out, and using the usual back bearing technique, position is obtained. The hill and church of Figure 1 are replaced by two radio stations. If the heading of the vehicle is not known, a fix can still be obtained if three radio stations of known position are available, but the geometrical construction is a little more complicated.

The principal disadvantage of such a system is that the accuracy is poor, partly due to siting variations as the vehicle moves about, and partly due to reflections of the radio wave from the ionosphere. Of course a special aerial system is required on the vehicle.

The accuracy may be improved by interchanging the transmitters and receivers. The system then is that a transmitter on the vehicle sends to two fixed receiving stations which measure the bearings of the received signals, work out the position and transmit the information back to the vehicle. Siting variations can be eliminated by calibrating the receiving stations, and the equipment to be carried on the vehicle reduced to a normal commu-

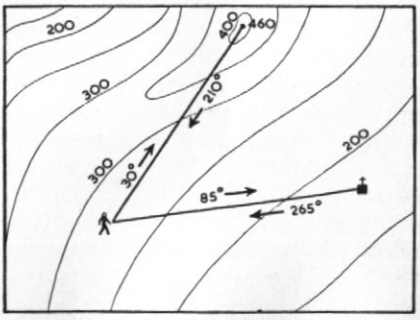

Fig. 1—Determination of position from bearings to two known points.

nication wireless set, but this arrangement introduces two other disadvantages:—

(a) The vehicle has to break wireless silence.

(b) The receiving stations can serve only one vehicle at a time.

To overcome these difficulties, various rotating beacon systems have been proposed. The principle will be explained in terms of visible light for simplicity. Suppose that a lighthouse operates on the following cycle:—

30 secs omni-directional flashing identification code.

30 secs. omni-directional continuous light.

60 secs rotating beam starting from north going round clockwise at uniform speed to reach north again after 60 secs.

A mariner can then obtain the bearing of the lighthouse quite easily. During the first half minute he identifies the lighthouse from the code; at the end of the second half minute he starts a stop watch and waits for the rotating beam to come around; when it does, he stops the watch and notes the time taken. Supposing that the time is 45 seconds, it is clear that the bearing from the lighthouse is:—

$$\frac{45}{60} \times 360 \text{ deg.} = 270 \text{ deg.}$$

and the ship is due west of the lighthouse.

Radio rotating beacons use the same principle, but the navigator usually has to find the minimum signal rather than the maximum as in the visible light analogy. A British system known as Consol has come into prominence recently. The timing is done by counting dots and dashes, so that the navigator requires a receiver only, and bearing is obtained by reference to a Consol lattice. This system is proposed for long distance navigation and from the military point of view, has the advantages that only a receiver is required on the vehicle, provided that an approximate bearing within 20 deg. is known. There is no need for a vehicle using the system to break wireless silence, and any number of vehicles can use it at the same time. Signals from two Consol stations are required to give a fix.

Measurement of Distance by Radio Pulses.

With the advent of radar a technique for measuring distance by radio means became available and was applied to navigational aids. To explain how distance can be measured, it is perhaps easier to consider first a sonic analogy.

Suppose that a man wishes to measure the distance to a cliff on the other side of a river. A possible method is to fire a pistol, wait for the echo to return from the cliff and measure the time interval between the shot and the echo. Knowing the speed of propogation of sound, he can then calculate the distance. This idea can be extended to measure the distance between two points, A and B, without using an echo. A man at A fires a pistol and a second man at B waits to hear the sound and then fires a second pistol. The time interval between A firing a shot and hearing the answering shot from B, is the time for sound to travel from A to B and back again, plus the time it takes B to react to hearing A's shot and

fire his own pistol. Knowing B's reaction time, the distance can once more be calculated.

The second method has three advantages; a greater range can be obtained, the answer comes from a definite point rather than some indeterminate point on the cliff, and no cliff or other echoing surface is necessary.

In pulse radar and navigational aids, a similar technique is used with radio waves instead of sound waves. In pulse radar, a transmitter sends a short burst of radio waves, stops, and then sends another short burst. In the intervals between bursts or pulses the radio waves travel to a target, such as an aeroplane or ship; are reflected back and picked up by a receiver adjacent to the transmitter, commonly using the same aerial system. The time interval between the transmitted and received pulses is the time for the forward and return journey, so that knowing the speed of propogation of radio waves, the distance is obtained. Usually the time measuring device is calibrated directly in terms of distance to the target. A point to be noted is that radio waves travel nearly a million times faster than sound waves in air, so that the time intervals to be measured are correspondingly reduced.

Alternatively, to measure the distance from A to B, a transmitter at A sends pulses, which are picked up on a receiver at B, amplified and retransmitted back to A, where again there is a receiver and time measuring device; time for the forward and return journey is obtained and hence the distance. In this case an allowance has to be made for any delay in receiving, amplifying and retransmitting the pulses at B. The device at B which performs these functions is known as a transponder or beacon. Clearly for navigation there are some advantages in this system; the range is increased for a given transmitter power and receiver sensitivity, the answering pulses come from a definite point and there is no need for any natural echoing surface; the beacon can be erected on a perfently flat plain if required, indeed this is the best site for it.

Radar as a Navigational Aid.

Having some understanding of range measurement in pulse radar it can now be considered as a navigational aid. Suppose that a vehicle is equipped with a radar set and operates in conjunction with a beacon at a known position. The radar set will give the range and bearing of the beacon realtive to the heading of the vehicle, so that together with a magnetic compass or other means for determining the heading of the vehicle, position can be obtained. The beacon can be designed to deal with several vehicles at a time (although the number is limited), and the system has been used extensively as an aircraft navigational aid. It is unsuitable for ground use, however, because of a line of sight path is necessary between the vehicle and beacon and a considerable amount of equipment is required on the vehicle. On aircraft, the system can only be justified when the radar set has to be carried anyway for some other purpose.

The system can be reversed so that the fixed station has the radar set and the vehicle carries only the transponder; this reduces the equipment to be carried on the vehicle and perhaps allows a standard radar

to be used as the fixed station, but a line of sight path is still required between radar and vehicle and there is the necessity for transmitting information to the vehicle. This system is also used as a navigational aid for aircraft, but on the ground its usefulness is very limited.

Normal radar technique does not seem very satisfactory as a navigational aid on the ground.

Double Range Systems.

An alternative system of position finding is to use two ranges instead of range and bearing. Suppose that a vehicle carries a pulse transmitter, a receiver and the usual time measuring device for measuring the intervals between transmitted and received pulses. Then by measuring the ranges to two beacons, a fix is obtained as in Figure 2. Thus, if the range to beacon A is five miles and to beacon B, nine miles, the vehicle might identify its position as P. But there is an ambiguity; the vehicle might equally well be at Q. The ambiguity may be resolved by use of a third beacon, but with suitable siting of the beacons this is unnecessary, since the vehicle has only to know whether it is to the left or right of the line through A B to decide whether it is at P or Q. Further, if approximate direction is known, the vehicle can move a little way, take another fix and ,according to whether distances to the beacons have increased or decreased, decide whether the position is to the left or right of line A B. The beacons must of course be identifiable by coded responses or similar means.

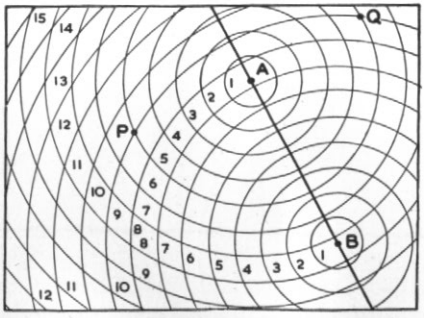

Fig. 2—Determination of position from ranges to two points.

Such a system has some advantages. Although the amount of equipment to be carried on the vehicle is still considerable, the aerial system can be much simpler than for the radar system discussed before, the accuracy is good and operation is no longer restricted to exact line of sight paths between vehicle and beacons. The beacons can serve several vehicles at the same time, but the number is still limited.

A double range system can be operated the other way round, measuring the ranges from the fixed stations and carrying the responder on the vehicle. This cuts down the amount of equipment to be carried on the vehicle, but the fixed stations can then serve only one vehicle at a time and the information has to be transmitted to the vehicle.

Double range systems were used during the war for blind bombing under names such as H, Oboe and Shoran; they were selected for this purpose because of the accuracy obtained.

Radio Propogation.

The reader will have noticed an inconsistency in these arguments; sometims a line of sight path for the radio waves is insisted upon

and sometimes it is not. To explain this is it necessary to put in a few notes on radio propagation.

Radio waves can travel from one point to another on the earth's surface either through the air just above the ground (ground wave) or by going up to the ionised layers, which exist some 50 to 200 miles above the ground, where they are bent back and return to ground (skywave). The latter process can be repeated several times so that radio communication round the earth by this means is possible. Clearly accurate ranges cannot be obtained if the waves travel by the roundabout ionosphere route; the direct route must be used instead.

At low radio frequencies (30 to 300 k c/s) radio waves travel with low ground wave attenuation, so that low frequencies have advantages for ranging type navigation aids, but a directional aerial for measuring bearings is impracticably large. These radio waves being of long wave length are able to go round corners to some extent and can penetrate to valleys on the remote side of low hills; a strict line of sight path is not necessary.

As the frequency is raised, radio waves tend to travel more and more in straight lines and by the time a frequency is reached at which it is possible to make a really good directional aerial for angle measurement, a line of sight path is necessary. This is the case using radar technique in the very high (30 to 300 M c/s) and super high (300 to 3000 M c/s) frequency bands.

The RDF technique mentioned usually works in the medium (300 K c/s to 3 Mc/s) and high (3 M c/s to 30 M c/s) frequency bands. At these frequencies, the only practical way to measure bearings is to work on a minimum; the aerial is swung either electrically or mechanically until minimum signal is obtained. Now this technique if used for a radar set would result in there being no signal on which range could be measured when the set was on bearing. The difficulty can be overcome (as in Radar AA No. 1 Mk 2), but the system is clumsy and not particularly accurate.

Hyperbolic Navigation Systems.

To avoid the necessity for breaking wireless silence, to reduce the amount of equipment to be carried in aircraft and at the same time to cope with any number of aircraft, a system known as hyperbolic navigation was developed during the war. As before, the principle will be explained by means of a sonic analogy.

Referring to Fgure 3, suppose that two men at A and B fire pistols simultaneously and an observer who wishes to know his position listens to the shots and measures the time interval between them. Suppose that this time interval is

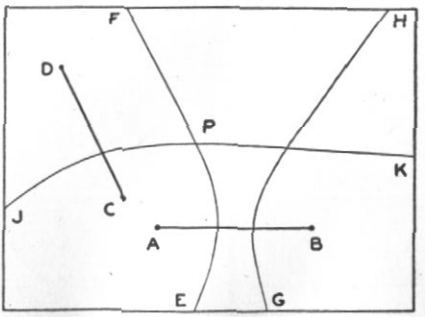

Fig. 3—Principle of Hyperbolic Navigation.

that required for sound to travel half a mile and that he hears A's shot before B's; he can then say that he is half a mile nearer A than B, and by doing a little mathematics he can say that he must be somewhere on a hyperbola such as EF. But the observer has no means of knowing that he heard A's shot before B's; it might have been the other way round, so that the observer can also be anywhere on a symmetrically disposed hyperbola such as GH.

The ambiguity of the two hyperbolae is easily resolved. Instead of A and B firing pistols simultaneously, arrange that A fires his pistol, B waits until he hears A's shot and then fires his pistol. The observer will always hear A's shot before B's now, but in working out the difference of his distances from A and B, he must allow for the time it takes sound to travel from A to B and for B to react to hearing A's shot and fire his pistol. As well as ensuring that one shot is always heard before the other, this arrangement also disposes of any difficulty in synchronising the shots. The observer is now sure that he is on hyperbola EF. By listening to two other men firing at C and D, he also determines that he must be on hyperbola JK and so obtains a fix of his position at P.

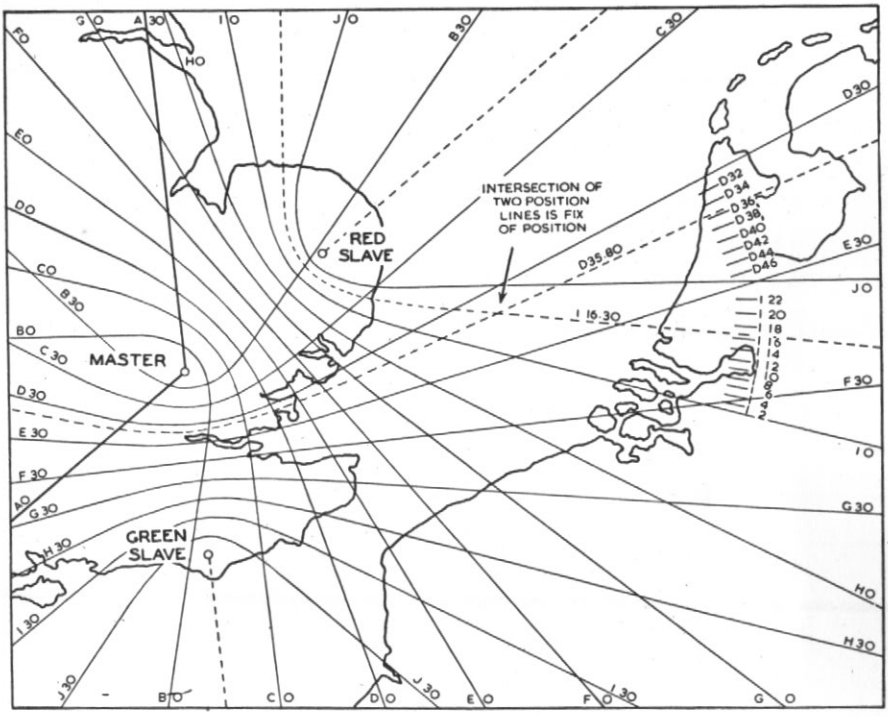

Fig. 4—Part of the lattice of the English Decca chain.

Hyperbolic navigation systems

using pulsed radio instead of sonic waves have been developed in various forms. The men at A, B, C and D are replaced by pulsed radio transmitters, the observers ears become a radio receiver and the time measuring device has to be suitable for the very short time interval between the arrival of the radio pulses. Usually stations A and C are combined into one master station and B and D act as slave stations triggered by the master. The technique of identifying the signals varies from system to system, as does the method of measurement of the time intervals between signals from the three stations. In any practical system, a map such as Figure 4 is prepared with a hyperbolic lattice superimposed on it, so that all that an operator has to do is find his position on the lattice.

The accuracy of hyperbolic systems varies according to position relative to the base stations, as well as the accuracy of timing of the transmitters and the accuracy of measurement of time intervals between received signals. Best accuracy is obtained where the hyperbolae are close together and cross nearly at right angles. The operating range obtainable depends upon various factors such as transmitter power, frequency, whether sky wave working is used and so on.

LORAN and GEE are both pulsed type hyperbolic navigational aids. LORAN (Long Range Navigation) is an American system developed as an aid for long-distance trans-oceanic journeys. It operates on about 2 M c/s, has a range of 750 miles by day using ground wave or 1,500 miles by night using sky wave and has an accuracy of about one per cent. of the distance from the base stations. GEE is a British system developed for blind bombing of Germany. It works in the 20 to 80 M c/s band, has better accuracy, but the range is limited to little more than line of sight, about 200 to 300 miles depending on height of the aircraft.

Continuous Wave Techniques.

So far, only pulsed methods of range measurement have been considered. Continuous wave methods are also possible and are in use. The principle will be explained in terms of sound waves.

Suppose that a man wishes to measure the distance between himself and a cliff face. Before he did it by firing a pistol and waiting for the echo; this time he will be equipped with a musical instrument capable of altering its note slowly and steadily up and down in pitch. Now the echo received will be of a different pitch to that being played at any instant, so that the beat note of the two will be dependent upon the speed at which the instrument alters its tone and the distance travelled by the sound to the cliff face and back again. Once more there is the basis for a system of range measurement.

In terms of radar, a transmitter alters the frequency of a radio wave continuously emitted, or carries modulation which alters frequency. By comparison of the transmitted signal and the received signal echoed back from a target, a measurement of range is obtained. Continuous wave radar has not received the same attention as pulse radar, but the idea has been applied to navigational aids.

The best known of the CW navigational aids is the Decca, which

uses a chain of three or four ground stations. A description is beyond the scope of this article, but it can be said that by comparison of the phases of signals received from the fixed stations, the navigator locates his position on a hyperbolic lattice in a similar manner to that described before. The system developed in UK uses the 80 to 150 K c/s band.

Conclusion.

No attempt will be made here to assess the relative merits of the various systems. For any given application there is an embarrassingly large number of possible systems available, some fully developed and some existing only on paper. The author does, however, wish to make two points. Firstly, these radio navigational aids were developed for use at sea and in the air; it does not follow that they will work equally well on the ground. Secondly, for the maximum amount of information for a small first cost, small size and light weight there is nothing to beat a prismatic compass.

However, some of these special aids will probably be used in survey work for triangulation, control of aerial photography and so on. Later, reconnaissance units may make use of either a special system designed for the Army or a system primarily intended for one of the other Services.