



Searchlights

R. H. Keate R.N.

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SEARCHLIGHTS.

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By COMMANDER R. H. KEATE, R.N.

NOTES ON THE EMPLOYMENT OF SEARCHLIGHTS AND LUMINOUS PROJECTILES IN LAND WARFARE.

GENERAL REMARKS.

AMONG the most recent technical aids to tactics, searchlights are of great importance; their employment is now common in night actions, and they have the effect of greatly diminishing the efficiency and volume of the enemy's fire.

However, they cannot be of much use unless properly placed and directed, for which much experience and practice are required.

SEARCHLIGHT UNITS.

A searchlight unit is composed of a searchlight and a power unit. The searchlight is an electric arc light, furnished with a reflector, which collects the rays of light and transmits them in the form of a cylindrical beam towards the object; the distance to which the beam reaches varies with the power of the light, which determines the diameter of the reflector.

The beam of light is directed towards the target by means of racks and pinions, which guide the beam horizontally and vertically, the racks being graduated in degrees to permit of laving the light by verbal orders.

In addition, there are the usual arrangements for regulating the distance apart of the carbons, and a shutter, or *jalousié*, by which the light can be diminished or obscured without extinguishing the lamp.

These operations can be performed directly, or from a distance by means of electric wires.

The power unit consists of a dynamo and a motor. The motor, besides actuating the dynamo, can be used for propelling the searchlight carriage in any required direction.

The searchlight also has a wire, connecting it to the dynamo, and two or more telephonic apparatus for communication between the searchlight operator, the observer, and the commander.

The personnel strictly required are an observer, two electricians, and a motorman.

The observer should be an officer instructed in the use of searchlights. One electrician directs the electric beam according to the telephonic orders of the observer, and the other looks after the dynamo;

the motorman works the motor and superintends the power unit. This complement should be doubled if possible, so as to form a searchlight section.

The searchlight units used by various armies are transported as follows :—

- (1) On their own special motor carriages.
- (2) On field artillery carriages.
- (3) On two-wheeled carriages.
- (4) By men on foot, or pack animals.

The motor carriages are required for large searchlights of 3,000 metres range and above, which are attached to large field units or to artillery, if the ground is suitable.

Searchlight units on artillery carriages are used in hilly country. Those mounted on two-wheeled carriages, though slow, are the best for mountainous and colonial work.

Hand transport is necessary in very mountainous country.

CHARACTERISTICS OF SEARCHLIGHTS.

Taking as the range of illumination the average distance to which a good observer with a good glass can see ordinary objects with certainty from a position near the searchlight, the following table is obtained :—

A 25-centimetre 10-inch light ranges 800 metres (900 yards)									
35	14	1,000	(1,111	35	14	1,000	(1,111	35	14
60	24	2,000	(2,222	60	24	2,000	(2,222	60	24
90	36	3,000	(3,333	90	36	3,000	(3,333	90	36
150	60	5,000	(5,555	150	60	5,000	(5,555	150	60

For the 90-cm. (36-inch) light there are also the following data :—

At 1,000 metres. Intensity of light, 53 candles per sq. metre									
2,000	12	2,000	12	2,000	12	2,000	12	2,000	12
3,000	5	3,000	5	3,000	5	3,000	5	3,000	5

One candle-power per square metre is equivalent to seven times the power of the full moon.

In practice it is not convenient to use searchlights of more than 90-cm. (36 inches) diameter, because of the infrequency of operations on level ground void of vegetation and houses, for ranges of more than three kilometres (3,333 yards); besides, the angle at which the beam of light cuts the ground at great distances becomes so acute that large shadows are produced by any vegetation or small hills which the beam encounters.

The area illuminated (intersection of the luminous beam with the ground) depends on the height of the searchlight above the target, on the inclination of the target, and on the distance between the light and the target.

Thus, on level ground a searchlight at 50 metres (55 yards) above the ground illuminates at 1,000 metres (1,111 yards) an ellipse of 1,000 metres longitudinal diameter.

At 2,000 metres the illuminated area is a parabola with the vertex towards the searchlight and about 1,000 metres from it.

The luminous beam cannot be seen through, so that all objects on the opposite side of the beam to the observer are screened from his view.

The visibility of the target depends on the contrast between it and the surrounding country, and on the colour and intensity of colouration of the target.

Light objects, especially on a dark ground, appear nearer than they actually are.

Colours are not seen as in daylight; yellow appears white; light green appears yellow; grey uniforms are practically invisible, especially against a grey ground; troops in white or black are easily seen.

Dry roads, earth mounds, walls, telegraph poles, leafless trees, appear clearly; wet roads and fields appear misty. Land sloping upward from the light is clearly seen, and looks higher than the reality, while small undulations of land look flatter.

Arms and accoutrements, especially the metallic parts, reflect the light, and are shown up clearly. Horses' eyes shine brightly with a greenish light, even at considerable distances.

Up to 2,000 metres small groups of men are seen, beyond this only large units in close formation; troops are seen more clearly when in movement; in extended order they appear more numerous on account of the shadows.

Moonlight, especially in front, diminishes the range of the searchlight; damp and rain diminish the range; fog and smoke are impenetrable to the electric rays. Thus, behind a smoke screen movements of troops can take place and work be performed without fear of discovery. Finally, the light of a searchlight diminishes the range of enemy searchlights of less power when directed towards them.

FUNCTION OF THE OBSERVER.

To obtain good observers they should be trained in peace time, and be selected from the various arms, the searchlights being an aid to the employment of their particular arms.

Thus, for searchlights that are to be directed on artillery positions, artillery officers should be attached to observe the effect of gun-fire when assisted by searchlights.

Under the general instructions of the commander, the observer chooses the positions of the searchlights and his own position.

The highest positions are most suitable for the lights, especially if they allow of a flanking illumination of the undulations in the landscape which run parallel to the front.

According to the length of the electric wires, searchlight positions must also allow of placing the power units under cover.

If, in the sector assigned to a searchlight, there are such inequalities in the surface of the land that important zones are left in shadow, the lights on either flank are placed so as to command these zones as far as possible.

The best observing positions are slightly higher than the searchlight positions, when possible.

The observing positions should not be near enough to be disturbed by the lights, and not far enough off to reduce the luminous zones viewed by the observers. These desiderata are practically fulfilled by a distance of 50 metres.

Level and clear ground gives greater scope to the powers of searchlights, but makes observation more arduous, as there is more ground to search.

Over close country observation is more difficult, but can be restricted to the directions of likely enemy approach.

The observer should accurately reconnoitre the ground in front during the day, and prepare a sketch showing the ranges and angles of depression of his light for the most important points. The choice of these points depends on tactical circumstances, such as the enemy's objective, his probable intentions, the zones of easy enemy advance, points of his inevitable passage, road junctions, good defensive positions, etc.

The searchlight can be used beyond its proper range if the observer goes forward sufficiently to compensate for the diminished luminosity. Thus, searchlights of 90 cm. (36 inches) diameter can range up to 4,500 metres (5,000 yards); 75 and 60 cm. lights can range 3,500 metres; and 40 cm. lights can range 1,500 metres.

The observers should be in telephonic communication with the commander for orders and instructions, and with the searchlight operators for directing the search and the switching on and off of the lights.

If electrical command at a distance allowed of giving exact and continuous training and elevation, the observer could direct the beam himself, but hitherto this has not been found possible, and it is necessary to pass orders to the electricians.

Special signals are arranged between the motorman and electricians with regard to switching the lights on and off.

The observer should not comply with requests which conflict with the commander's orders, which requests may often come from adjoining stations.

In night observation a telescope is better than binoculars because the magnification of the target is more important than magnification of the field of vision. If binoculars are used they should not be above power 6, otherwise the luminosity of the image will be too much diminished.

ACTION OF SEARCHLIGHTS.

- (1) *Exploration*.—Observation of the enemy's operations.
- (2) *Battle*.—Facilitation of gun-fire by illumination of the target presented by the enemy forces.
- (3) *Moral*.—Retardation of the enemy's advance, the latter thinking his plans are discovered.
- (4) *Material*.—Blinding the enemy and disturbing his forward march and firing capacity.
- (5) *Signalling*.—Signals made by searchlights are visible up to 70 kilometres (40 miles).

EMPLOYMENT OF SEARCHLIGHTS BY THE DEFENCE.

On the defensive, especially in prepared positions, searchlights can be disposed accurately and scientifically. Having found the general direction of the enemy's probable approach, the commander of the defence, aided by the commander of engineers, disposes the searchlights along the front, generally in groups, one group to each sector of the defence.

Each commander of a searchlight group decides on the positions of his searchlights and indicates the sector each one is to guard; he is in telephonic communication with the commander of the defence and with the observers of his group.

The commander of the defence keeps the group commanders informed of the situation, objective, his own intentions, and those of the group commanders in the vicinity; this information must be given in good time, in order to allow the group commander to define the exact duties of the observers.

The sector of exploration assigned to each light is limited to about 60° , as a larger angle than this would diminish the efficiency of the exploration. There is generally one searchlight of 90 or 75 cm. to each kilometre of front, and a few in reserve. In mountainous country the number of lights can be reduced as higher positions are available so that each light commands a greater zone.

Heavy searchlights of long range are usually placed behind and above the firing line. If no elevated positions are available, and there is no time to construct elevated mountings, the lights are placed on the flanks, or in the intervals between the regiments.

Small searchlights can be placed slightly in front of the firing line if the country is undulating, arrangements being made for withdrawal in case of surprise or attack.

Between the long-range lights, shorter-range lights of under 75 cm. are placed, in such numbers as the conditions of transport and configuration of the country allow. The smaller lights are generally assigned to the infantry.

After making a daylight reconnaissance, the observer decides on the positions of the searchlights and of the observer, the communications between them, and, according to the situation and orders received, he arranges the details of procedure as before described.

The lights should not be placed all on the same line, or in such a manner as to indicate the extremities of the defensive position.

In order to surprise the enemy while in movement, and to avoid becoming a target for his artillery, the electrician directs his light at irregular intervals on the most important points of the country in front, such as zones of easy enemy advance, road junctions, points of inevitable enemy passage, good positions for resistance, etc.

The light is not shown for more than twenty seconds at a time, which is too short an interval for the enemy to get the range.

Large searchlights, besides exploring the country as far as its configuration allows, are of great assistance to the defence when firing at infantry advancing to the attack.

The infantry of the defence can sometimes open fire at a considerable distance from the attackers with the help of the searchlights; for this purpose it is useful to select by day numerous imaginary targets as offered by the landscape on the lines of probable enemy approach.

The large lights also neutralize the action of enemy lights and form luminous curtains, masking the movements of the counter-attackers. They must avoid lighting up their own defences or any obstacles likely to impede the enemy's advance.

The enemy's artillery are not often discovered, being generally beyond the range of searchlights.

When the attacking infantry are less than 1,000 metres off, instead of shifting the long-range beams, the small lights come into play, thus assisting the rifles and machine-guns of the defence.

The enemy is lit up as long as possible with due regard to the danger incurred by the searchlights. If there are four lights per kilometre, two can take any target alternately; if less than four they must be traversed during the intermissions of light.

The machine-guns can fire while the enemy is lit up by the beams, and also during the obscurations.

In order to defeat the enemy when he is trying to overcome obstacles or destroy auxiliary defences, a certain number of small lights must come into action at the right moment: oxy-acetylene lights are useful for this purpose.

When the small lights are in use, the large ones can light up the more distant zones, and thus surprise enemy reinforcements and reveal the arrival of material for the assault.

EMPLOYMENT OF SEARCHLIGHTS ON THE OFFENSIVE.

In this case searchlights have fewer opportunities, as the attacker endeavours rather to take advantage of the darkness to surprise the defender's position which he has reconnoitred or attacked unsuccessfully during the daytime.

Nevertheless, searchlights can be used in case of a check in the attack, due to heavy losses or other cause. The attacker's searchlights are then used as follows:—

- (1) They allow the attacker's artillery to fire against the defender's positions.
- (2) They light up the defence and disturb the defender's proceedings.
- (3) They counteract the defender's searchlights by blinding his electricians with their own rays.
- (4) They neutralize the defender's searchlight beams.
- (5) They establish a zone of light in front of the attacker's columns, lighting up the line of advance to his own troops and hiding it from the defence; this screen should be mobile and directed so as to deceive the enemy as to the direction of the advance.
- (6) They help by revealing obstacles to their own artillery, which is thus enabled to destroy them.

- (7) They light up the whole defensive position when about to assault.
- (8) Just before the assault they discover the enemy reserves behind his firing lines.
- (9) They cover the retreat of an unsuccessful attack.

To perform these duties the lights must be mobile, mounted on carriages able to traverse any country, and be capable of being mounted and dismounted from the carriages to facilitate their transport and installation.

USE OF SEARCHLIGHTS ASSIGNED TO THE OUTPOSTS.

A good use may be made of them, at the same time increasing the safety of the troops, in enabling the complement of troops required for outposts to be decreased as follows:—

- (1) They illuminate the most important lines of approach.
- (2) They help in the outpost actions, lighting up and blinding the enemy.
- (3) They cover the retirement of the outposts with a screen of light.
- (4) They assist the aim of the artillery and machine-guns of the defence.

The rules for their employment by outposts are practically the same as for the defence in general.

EMPLOYMENT OF SEARCHLIGHTS IN COLONIAL WARS.

Here the enemy has little or no artillery, and is not much skilled in such as he does possess; the landscape is generally open and undulating, which allows of augmentation in the period of illumination and of decrease in the number of lights.

The lights can be placed at intervals equal to twice their range; particular attention must then be paid to the zones in shadow, due to the undulations of the country; if there are not enough lights to deal with these zones, small lights such as oxy-acetylene lights can be directed on the auxiliary defences and natural obstacles.

Large lights are used as follows:—

- (1) Having fixed the vertical angle of the light to cover a certain range, generally 1,000 metres, the lights are trained round till they meet the adjacent searchlight sectors of illumination, or if there is only one light the training is stopped when it comes near to discovering the defending troops. This training should be performed as fast as the observer can follow the beam with a telescope.
- (2) If during the training small groups of men are discovered, the movement should not be checked, as there might be larger enemy forces further round.
- (3) When a considerable force is discovered, the electric beam is stopped in its horizontal rotation and elevated as necessary to show up the enemy's depth of formation, and thus assist the aim of the artillery.

- (4) If no target is found during the sweep round, it is repeated at a different elevation, and so on up to the maximum range of the light. Between successive sweeps the light can be obscured for a period less than the enemy would take to get through the illuminated zone.

In the Colonies, good high positions are seldom available, and elevated bases must be constructed of wood or iron to overcome this difficulty.

Finally, care must be taken that the auxiliary defences and obstacles to the enemy's advance are not lit up.

At the proper moment, however, the small searchlight beams are thrown on to these points, while the large ones are directed towards the enemy's rear so as to show up the depth of his formation.

PROCEDURE OF THE ATTACKER UNDER THE RAYS OF THE SEARCHLIGHTS.

If the attacker expects to be exposed to the searchlights of the defence he covers up all objects that reflect light, such as trumpets, drums, helmets, etc.

The infantry, when at a distance of three kilometres, is in column of companies at convenient intervals, a formation which enables them to take advantage of the shadows.

Roads and zones without cover, or slopes descending towards the enemy, are avoided if possible; if impossible to avoid these, the attackers advance at greater speed and in open formation while crossing them.

If they find themselves subjected to the luminous rays of the defensive searchlights, they throw themselves on the ground and take cover in the shadows caused by the inequalities of the ground, and they should endeavour to do this before the whole column is discovered.

When there is no cover, some officers advise taking leafy branches and making use of their shadows as cover when lying down.

The officers are all on foot, as horses are liable to stampede and give away the column. If horses are employed they should be turned away from the lights directly they are caught by the rays.

The attackers profit by the moments when the lights are obscured, or turned away from them, to make a rapid advance.

When arrived at rifle range the troops proceed as in the daytime.

VULNERABILITY OF SEARCHLIGHTS.

Direct firing at searchlights is impossible on account of the blinding effect of the rays, and the estimation of range becomes inaccurate, for the opening and closing of the shutters and consequent flickering of the light, causes large errors in the enemy's aim.

However, artillery can fire if the observers and commanders are not themselves in the luminous beam. Percussion fire gives better results than shrapnel fire. Rifle fire is only effective at close range.

Russia has the best organization of searchlight units in the world.

The war with Japan made Russia understand the importance of this service, and after much experiment and study she has assigned to each army corps of two divisions, twelve searchlight units organized as follows:—

- (a) One unit of 90 cm., on motor carriage, for each army corps.
- (b) One unit of 75 cm., in parts, carried on four-wheeled and two-wheeled carriages for each army corps.
- (c) Two units of 60 cm., one for each division, carried as in (b).
- (d) Eight units of 40 cm., on two-wheeled carriages, very mobile, one for each regiment of infantry.

There are also special units of 40-cm. lights for mountain troops and mounted troops.

LUMINOUS PROJECTILES.

The luminous source of these projectiles is obtained by means of Bengal lights with parachutes or by the bursting of the projectile into stars.

Germany, Russia, Japan, and Austria use the parachute type of projectile which appears to be preferable to the star shells employed by England and France.

In order to obtain less residual velocity at the point of culmination, and to increase by a very curved trajectory the duration of the light, luminous projectiles are fired from howitzers or mortars.

The only importance of obtaining greater duration of light is the economical question and the facility of re-munitioning and loading; with proper regulation of the intervals between successive shots the light can be made continuous.

Luminous projectiles are employed thus:—

- (1) For continuing by night a bombardment regulated during the day.
- (2) To discover particulars of enemy objectives hidden by lights or fires which have been reported towards the front.

They are not used for long-distance exploration like searchlights, because their number is limited.

They have the advantage of giving zenithal light without shadows, and of not disclosing the position of the guns which fire them. However, the intensity of illumination is not sufficient for observation from the battery, and the observers must go well to the front and ascend in order to see anything.

Dirigibles and aeroplanes are well suited for the use of observers and can drop luminous shells themselves.

In Germany, in the 1910 manœuvres luminous projectiles fired from special pistols were tried, which illuminated the country around within a radius of 200 metres for a period of twenty seconds.

Those fired from special rifles had a duration of forty seconds.

These special luminous shells are used:—

- (1) To show up the line of march by night.
- (2) Suddenly to light up particular zones on the field of battle.
- (3) As a means of signalling.