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INSTRUCTIONS TO LIGHTKEEPERS  
ON FIRST-ORDER TRIANGULATION

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## PREFACE

### NOTE TO LIGHTKEEPERS

The purpose of this pamphlet is to instruct you in the work you are to do on a triangulation party. Before you start out alone be sure you know the uses and adjustments of the compass and signal lamps. Know how to use your compass in orienting the reconnaissance sketch so that the north lines on the sketch point to the true north. The compass needle in most regions does not point true north and, besides, is easily deflected by nearby iron or steel objects.

There are three fundamental rules for a lightkeeper to follow:

(1) *Know the code.* Practice at every available opportunity. A poor signalman makes a poor lightkeeper.

(2) *Know your instruments and take care of them.* Be thoroughly familiar with dry cell hook-ups and know how to use them most efficiently.

(3) *Get your light through.* Many times weather conditions and unforeseen troubles or accidents will tend to discourage you, but you will be surprised how many times hard and diligent work will overcome these difficulties and turn a night which was apparently lost into a successful one.

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# INSTRUCTIONS TO LIGHTKEEPERS ON FIRST-ORDER TRIANGULATION

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## INSTRUMENTS AND EQUIPMENT

As soon as you have joined a party you will be issued a number of instruments and general property. Make a list of what is issued you and keep it for reference. You will be held responsible for everything on this list. Familiarize yourself with all of it and take good care of it. Be sure to check the numbers of all instruments and put them on your list.

This list of equipment will usually be as follows:

- 1 ammeter, pocket, no. -----
- 1 binoculars, no. -----
- 1 compass, azimuth, pocket, no. -----
- 1 cot, folding.
- 1 flashlight.
- 1 to 3 or more, lamps, signal, nos. -----, -----, -----, -----
- 1 packsack.
- 1 pliers.
- 1 screwdriver.
- 1 tarpaulin, 5 feet by 5 feet.
- 1 tarpaulin, bed, 7 feet by 14 feet.

A certain number of dry cells, a battery box or lumber to make one, a supply of battery clips, a supply of insulated wire for dry-cell connections and leads, and a supply of extra bulbs for both signal lamps and flashlights will also be issued to you.

There are two of the above instruments with which you must familiarize yourself thoroughly. These are the compass and the signal lamp.

## COMPASS

The use of the compass will have been explained to you before you are left alone. You will have been given the variation of the compass needle from true north for the locality in which you are working.

To test a compass, compare it with another, known to be correct, or test it on some line the azimuth of which is known. Always be sure the needle is lifted from the pivot when carrying your compass as it is easy to injure the delicate point of the pivot.

Remember that a compass needle is deflected by a nearby mass of steel or iron. Do not use it on a steel tower unless you are standing on top of the light-keeper's platform with the compass about 5 feet above all steel. Even then do not trust it for an accurate line, but use the following method. While on the ground, go about 50 feet from the tower and point at some cardinal point of the compass. Mark it well by noting some building, hill, or tree on the horizon. Then climb the tower and use that point in orienting your reconnaissance sketch.

## SIGNAL LAMP

The electric signal lamps now supplied are of two sizes. The standard lamp has a 7-inch reflector and the small lamp has a flashlight-size reflector. The standard lamp is used most of the time but, for short lines under 5 miles in length, it often gives too bright a light and the small lamp is used. At times in clear mountain or desert air a small lamp has been used on lines up to 40 miles in length.

**Reflector.**—The reflector is of frail construction and must be handled carefully to prevent tarnishing and scratching. It should be polished with soft chamois

## INSTRUCTIONS TO LIGHTKEEPERS

skin or tissue, using only cleaning preparations which are recommended by the Instrument Division.

In an emergency a reflector may be replaced by purchasing the old type of Ford headlight which usually can be obtained in the larger towns. Reflectors can also be resilvered or replated with chromium in the field at a moderate cost. A lamp which has been in service about a year is usually in need of resilvering.

**Sighting device.**—Signal lamps, as now built, have a front sight on the reflector just back of the lens frame and a notched rear sight fastened to a bracket on the rear of the reflector for the purpose of sighting the light. The rear sight is adjustable by means of knurled thumbscrews, both horizontally and vertically.

**Focusing device.**—This is the small knurled thumbscrew about one-half inch to the right of the rear of the bulb socket. This screw passes through a collar which encircles and is made fast to the bulb socket. By turning this screw in and out the position of the bulb is changed in relation to the reflector.

When a lamp is old it frequently will not focus well owing to this collar being worn. It can be repaired by using a nut or ring placed underneath the collar to make it longer. A lamp should be torn down and this focusing device examined to get a proper understanding of its operation.

### BATTERY CONNECTIONS

With the lamp properly pointed and focused, the brilliancy of the light will depend upon three factors—the number of dry cells used, the method of connecting them, and the kind of bulb used. Different methods of connecting the cells will be described first.

Figure 1 shows several cells connected in series, the carbon pole of one being connected to the zinc pole

of the next. When thus connected, each added cell increases the voltage, and the total voltage is the sum of the voltages for the individual cells. There is a proper voltage for each lamp bulb. If the voltage is too low, a dim light will be obtained; while if it is too high, the bulb will be burned out.

Figure 2 shows cells connected in parallel, all the carbon poles being joined together and all the zinc poles.

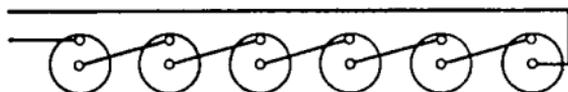


FIGURE 1.—Cells connected in series.

There will be 24 amperes and 9 volts in the lamp circuit, assuming an average of 24 amperes and  $1\frac{1}{2}$  volts for each cell.

This method increases the amperage of the circuit, but the voltage is the same as that of a single cell. In

other words, it is equal to a battery with the same voltage as the individual cell but as many times larger as there are cells in the connection, thereby increasing the number of hours the lamp can be kept lighted.

Figures 3, 4, and 5 show different series-parallel connections and should be studied carefully. These di-



FIGURE 2.—Cells connected in parallel.

There will be 144 amperes and  $1\frac{1}{2}$  volts in the lamp circuit, assuming an average of 24 amperes and  $1\frac{1}{2}$  volts for each cell.

agrams are explained in detail in connection with the description of the different bulbs.

When showing from 3 to 6 lights, the hook-up ordinarily used is a set of 16 cells with 4 rows of 4 in parallel. The voltage may then be varied by using from one to four rows. When showing 5 or more lights over a period of 6 hours or more, the above set of 16 cells should be backed up with a second set of 16 in parallel.

## BULBS

**Low-amperage bulbs.**—The most commonly used bulb is the one rated at 0.6 ampere and 3.7 volts. This bulb is supplied by the office on requisition and requires the amperage and voltage marked on the base. When it is used in the size of signal lamp which has a reflector 7 inches in diameter, it gives very satisfactory results on lines which do not greatly exceed 25 miles in length. In case it is found necessary to have a brighter light on account of hazy atmosphere, it is possible to use a 1.25-ampere bulb (described on page 6). For ordinary cases with the small lamp and the 0.6-ampere bulb, 2 units of

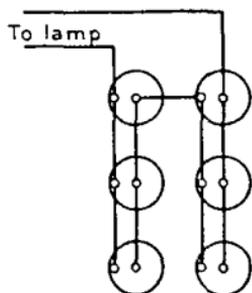


FIGURE 3.—Series-parallel connection of 6 cells in 2 units of 3 cells each.

There will be 72 amperes and 3 volts in the lamp circuit, assuming an average of 24 amperes and  $1\frac{1}{2}$  volts for each cell.

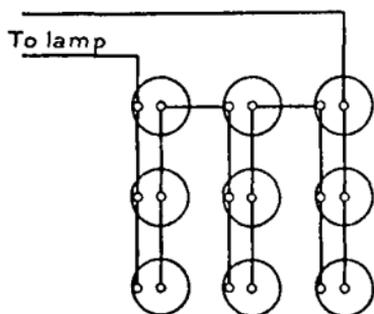


FIGURE 4.—Series-parallel connection of 9 cells in 3 units of 3 cells each.

There will be 72 amperes and  $4\frac{1}{2}$  volts in the lamp circuit, assuming an average of 24 amperes and  $1\frac{1}{2}$  volts for each cell.

new cells, each unit containing three cells connected in parallel (see fig. 3), will be sufficient to give a very satisfactory light for 6 hours a day for 10 days. Although rated at 3.7 volts, these bulbs will stand 4.5 volts, or three units of new cells, since the voltage of an ordinary cell, or of a unit of two or more cells connected in parallel, is about  $1\frac{1}{2}$  volts. Four units

of new cells would have a voltage of 6, which would burn out a bulb of this type.

After a period of use of the two units of three cells each the voltage will decrease and the cells will no longer furnish a satisfactory light. A third unit should then be added and later a fourth unit. When

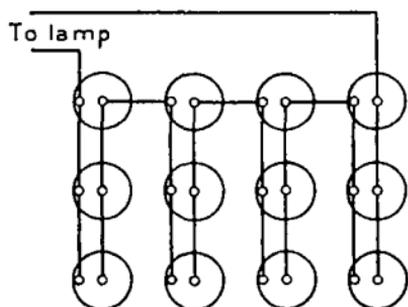


FIGURE 5.—Series-parallel connection of 12 cells in 4 units of 3 cells each.

There will be 72 amperes and 6 volts in the lamp circuit, assuming an average of 24 amperes and  $1\frac{1}{2}$  volts for each cell.

the four units no longer give a sufficiently brilliant light, because of the drop in voltage, the two oldest units should be removed and replaced with one new unit. Be careful not to connect up enough cells to give a voltage more than the bulb will stand. After a period of rest the cells removed may be used again with others of about the same degree of exhaustion. Very weak cells should not be use in combination with new ones.

**High-amperage bulbs.**—The office also furnishes a bulb rated at 1.25 amperes and 3.7 volts. This bulb is the same size as the 0.6-ampere bulb and can be used with the same battery. It is to be used in cases where the 0.6-ampere bulb will not give a sufficiently powerful light. This bulb will consume twice as much current as the 0.6-ampere bulb and should not be used where the other will be satisfactory. When cells are new, the 1.25-ampere bulb should be supplied by two units connected in series, each unit consisting of three or four cells connected in parallel, extra units being added as the cells weaken. (See figs. 3, 4, and 5.) Three units of new cells in series will give as great a

voltage as the bulb will stand, since it is rated the same in this respect as the 0.6-ampere bulb.

**High-voltage bulbs.**—The office will also furnish for special cases a bulb rated at 2 amperes and from 6 to 8 volts. This bulb consumes such a large amount of current that it is not economical or practical except in cases where the observer desires not only a brilliant light, but also a light with its beam slightly diffused.

With fresh cells, 5 units of 4 cells each should burn well for about 20 hours, after which the brilliancy will be reduced noticeably. Other units should be added one at a time as needed. When 8 units do not give the required amount of light, the older cells should be thrown away and fresh units used. A comparison of the number of cells used with this bulb and with the smaller bulbs readily shows why this lamp is not practicable. It gives a beam only slightly more intense, and it requires a large number of cells which is undesirable when weight is a serious consideration.

#### TESTING CELLS

Use the pocket ammeter to test the cells as they are used. Cells which show no energy should be thrown away because when they are placed in circuit with other cells they cause more resistance to the current and tend to reduce all to an average voltage. In general, cells of less than 4 or 5 amperes will be of no use. Cells which are cold never test well and will show a poor light. When cells are cold you should warm them and test them before throwing them away as worn out. Freezing permanently injures dry cells.

#### USE OF AUTOMOBILE STORAGE BATTERIES

Automobile storage batteries of the ordinary 6-volt type have been used frequently in recent years with

satisfactory results. When used they should be tested frequently with a hydrometer and not allowed to drop so low before being recharged that they are permanently damaged.

By using the proper terminals on a storage battery, voltage may be varied from 2 to 6 or 8 volts. A fresh storage battery has the advantage of supplying heavy amperage and will run for long periods without the lights being dimmed by a loss in voltage. Consequently they are frequently used by observing parties which generally have a call light with a 6-volt bulb. Storage batteries must be handled with care to prevent the acid from spilling and ruining a packsack or other equipment.

As an emergency measure on a steel-tower project, when dry cells have become low, lightkeepers driving trucks have used the truck battery in the following manner. The truck is driven close to the tower and the battery connected to the tower by wiring one terminal to the inner tower and the other to the outer tower. Then leads may be taken from the inner and outer tower at the top. This will not be satisfactory when the ground is too wet as the current will short through the ground. You can test this by putting an ammeter in the line after connection is made at the base of the towers and noting whether or not the discharge is heavy.

#### ADJUSTMENTS OF LAMP

Aside from the electric connections there are only two adjustments needed for any of the lamps—one for focus and the other for the sighting device—and these should be tested frequently.

**Focus.**—The lamp must be properly focused at all times. No matter how brilliant the filament of the bulb may be, the light will not be effective at any distance unless well focused. Each bulb will be found to require a slightly different focus, and this is true even of the same kind of bulbs of apparently the same size, because the position of the filament relative to the base of the bulb is rarely exactly the same. Therefore, focus the lamp every time the bulb is changed and refocus after the lamp has been shipped or carried by truck or pack horse, since the vibration while traveling will quite likely cause a change.

The focusing adjustment is made by the screw socket into which the bulb fits (see p. 3). Focusing can be done either at night or during the day. At night focusing is best done by directing the light upon a flat surface, such as a tarpaulin or tent, about 100 feet away and turning the adjusting screw until the brightest part of the disk is but a little larger than the lens of the lamp. As much light as possible should be concentrated within this area.

During the day the focusing can be done by standing about 100 feet away from the lamp, with your eyes in the path of the beam, and have some one turn the focusing screw back and forth until that point is found where (1) the light is brightest, (2) there are no black rings or spots on the reflector, and (3) the "spread" of the bright beam is little more than 1 foot, as found by moving the eye up and down and side-wise in the path of this beam. The lamp is then in focus.

**Lamp sights.**—The center of the most brilliant part of the beam must be pointed to the observer, and if the sights are used in pointing, they must be parallel

to the light beam. To adjust the sights by night, point the light to some object near enough to outline the central bright beam and after loosening the knurled nut which holds the rear sight bracket, adjust it so that the sights point to a spot as far above the center of the beam as sights are above the center of the reflector. Then tighten the nuts to hold the bracket and sight in that position.

This adjustment may also be made during the day. Place a stake in the ground in the path of the light and make a mark on the stake at the point where the reflector shows the brightest. This point may be found by moving the eye up and down and sidewise just back of the stake in the same manner as when focusing the light. Then adjust the rear sight so that the sights point to a spot the same distance above the mark on the stake as the sights are above the center of the reflector. Adjustments of the focus and sights may be advantageously made at the same time.

When the adjustments are properly made, the bright beam of the light will go to the observer if the sights are pointed at him. At night the pointing may be made upon the observer's light by sighting accurately along the beam—from directly above it for line and from the side for elevation.

*A light not properly pointed may either be invisible to the observer or may cause errors in the observing which cannot be detected until all the stations of the triangle have been occupied, and thus may cause great delay and expense.*

#### USE OF AUTOMATIC SIGNAL LAMPS

Under certain conditions, when the party is short handed, automatic lighters are used. These lighters

are controlled by a clock which turns on the light during certain hours for which the clock is set. Since these lighters are seldom used, no extensive explanation of their use will be given here. Complete instructions are issued with each lighter, which may be studied when they are to be employed on the party.

## INSTRUCTIONS FOR SIGNALING

### INTERNATIONAL MORSE ALPHABET

A . _ _	J . _ _ _ _	S . . .
B _ . . .	K _ . _ _	T _
C _ . _ . .	L . _ . .	U . . _
D _ . .	M _ _ _	V . . . _
E .	N _ .	W . _ _ _
F . . _ . .	O _ _ _ _	X _ . . . _
G _ _ . .	P . _ . . .	Y _ . _ . _
H . . . .	Q _ _ . . _	Z _ _ . . .
I . .	R . _ . .	

### NUMERALS

1 . _ _ _ _ _	6 _ . . . .
2 . . _ _ _ _	7 _ _ . . . .
3 . . . _ _ _	8 _ _ _ . . .
4 . . . . _	9 _ _ _ _ .
5 . . . . .	0 _ _ _ _ _

### INSTRUCTIONS FOR USE OF CODE

BT \_ . . . \_ used between angles in place of "stop."

Question (?) . . \_ . . .

Transmit all angles by numerals.

Before sending numerals send "NF" to signify "Numerals follow."

When finished transmitting numerals send "LF", meaning "Letters follow."

Between the degrees and minutes, minutes and seconds, and in place of a decimal point, send the letter "R."

Example of the correct way to transmit an angle:

The angle  $135^{\circ}46'39.26''$  would be sent as follows:

NF135R46R39R26

Where there are several angles to be sent, as when directions are transmitted, they will be sent as follows:

30°45'25.22''	}	NF30R45R25R22 BT 90R26R12R98 BT	
90°26'12.98''			
135°38'11.23''			135R38R11R23 BT 171R16R55R52 BT
171°16'55.52''			198R41R37R12
198°41'37.12''			

Use extreme care in sending numerals; and if any numeral is lost in receiving, break in at once with "R." Do not guess.

The International Morse ("Continental Code") differs from the American Morse in that there are no "spaces" between the elements of the letters.

The alphabet must be committed to memory; also, what is more difficult, *all letters must be quickly recognized by seeing their elements*. Perfection in this matter will eliminate much trouble and misunderstanding, as most of the difficulty is due to the receiver's inability to recognize a letter before the next one has begun.

Dots should be short, just long enough to permit the light to be seen clearly. For dashes, the light should shine for about 2 seconds.

The duration of darkness between elements of letters should be 1 second; between letters, 3 seconds; and between words, 5 seconds. It is not important that these periods should be absolutely observed, but the relative proportion should be maintained. Moreover, a uniform speed should be maintained in sending, for varying speeds make the receiving of the message difficult. Use the signaling key on the lamp for all signaling.

**Calling.**—A lightkeeper calls the observer or another lightkeeper by sending a series of dots until answered.

The observer calls a lightkeeper by showing a steady light to him. A steady light from the observer's station means either that he wishes to send you a message or that your light is not satisfactory. First, inspect your light and then answer the call. If the reason for the call from the observer was your unsatisfactory light, the observer will O. K. by dots as soon as the trouble is corrected and will then turn off his light.

**Answering calls.**—A lightkeeper answers a call by a series of one-second dots (not more than seven), then, *with his light steady on the observer*, watches for the signal by aid of the binoculars if necessary. When two lightkeepers are so located that each is able to see the light intended for the other, both must answer when called, then the letter of the light desired will be sent by the observer.

**Receiving messages.**—If the lights are faint, before beginning a message give the one to whom it is sent time to steady his binoculars on the light before cutting it off. Darken the light for about five seconds before beginning message. The practice of sending dots before darkening the light is often confusing on long lines and should not be practiced unless authorized by the chief of party. Do not cut off your light while receiving a message.

All messages are to be repeated by the receiver, except messages from lightkeeper to observer. Here the observer will answer by sending one-second dots. NEVER REPEAT A WORD UNLESS YOU ARE SURE IT IS RIGHT. This is a decided annoyance to the observer and a source of a great deal of trouble. If an observer knows that a

message has not been received, he is at least in a position to know what to do to remedy matters. SHOULD YOU FAIL TO GET THE FIRST PART OF A MESSAGE, BREAK IN WITH "R." DON'T WAIT UNTIL MESSAGE HAS BEEN COMPLETED. If first part of message has been received, repeat words you are sure of, then send "R" for remainder. Where lights are faint or lightkeepers not skilled in receiving messages, it is better for the observer to send one word at a time and have that repeated before proceeding to the next.

#### CODE SIGNALS

A series of one-half-second dots means "I have made a mistake and will begin again."

A series of one-second dots means "I understand your message."

"R" means "Repeat your message, I could not get it."

Lightkeepers in relaying messages refer to observer as "O", "OO", "OOO", etc., according to which observer is meant. When there are more than three observing parties, special designations for the others are selected by the chief of party. Designations commonly used are "Four O", "Five O", "Six O", etc., which are signaled as follows, using a combination of the numerals and letters:

Party	Call letters
Four O	..... — — — —
Five O	..... — — — —
Six O	— ..... — — — —

## SIGNALS TO BE USED BY OBSERVERS TO LIGHTKEEPERS

- A ----- Wait a while.
- AA ----- Stand by. Will need you soon.
- N ----- Your light is too faint. Brighten it.
- M ----- Your light is too bright. Moderate it.
- Z ----- The distinctive letter of the O-party. It means,  
 "We are about to start observing on you."  
 The lightkeeper on receiving a Z, will O. K. it  
 by repeating it backward to the O-party, thus,  
 . . . — —
- ZZ ----- The letter of the OO-party. It is returned as  
 follows: . . . — — . . . — —
- ZZZ ----- The letter of the OOO-party. Returned: . . . — —  
 . . . — — . . . — —
- 4-O ----- The letter of the 4-O party.  
 Sent as follows: . . . . . — — — —  
 Returned: — — — — . . . . .
- 5-O ----- The letter of the 5-O party.  
 Sent as follows: . . . . . — — — —  
 Returned: — — — — . . . . .
- 6-O ----- The letter of the 6-O party.  
 Sent as follows: — . . . . . — — — —  
 Returned: — — — — . . . . .
- DONE ----- You can turn out your light to this observing  
 party. Continue to show to other parties until  
 they signal you that they are finished. How-  
 ever, you must continue to look for calls and  
 must not leave station until DG is sent you.
- DG ----- The finished signal for the night. It means all  
 observing parties are through and everyone  
 may return to camp.

SIGNALS TO BE USED BY OBSERVERS TO LIGHTKEEPERS IN MOUNTAIN  
 TRIANGULATION (PARTIES CAMPING AT STATIONS)

- DG ----- This now means "Done where you are; go to your  
 next station as indicated on your schedule of  
 moves and show to the observing parties sched-  
 uled on the next observing period."

- DG ONE ---- Same as above except that the one indicates that one day will intervene before the observing parties will attempt to observe. Similarly any other number as "Two, Three, or Four" may be used.
- ST ----- Stop showing light to the stations shown on your schedule. Remain at your station and show light to the scheduled observing parties on the next observing period.
- ST ----- Followed by the name of a station, takes on the following meaning, "We are breaking schedule. Stop showing light to this station. At the next observing period show to the station named and look for a call from this party."
- ST ONE ---- Stop showing to this station now. Remain at your station and show to the station shown on your schedule. One day will intervene before the observers will be ready. Similarly, "TWO, THREE, or FOUR" may be used.
- THD ----- Finished with you for tonight. Remain at the same station and show to this station again on the next observing period.
- GET ----- Followed by the name of a station means, "Call the observing party at that station and tell them to show here." The lightkeeper will then call the station named and send the message, O (followed by the name of the station from which the call originated). If one of the other observing parties, originated the call, their call letter is substituted for "O."

#### GENERAL CONSIDERATIONS

Watch for signals at all times. It is a common fault for a lightkeeper to leave his tower for a time after he has received his Z's. This is a bad fault for he is often needed to moderate or intensify his light or to call another lightkeeper.

Watch carefully for N or M. These signals are almost always sent at least once or twice in an evening. A good lightkeeper can often anticipate such a signal by watching his light. Experience will tell him

whether it is too bright or too dim. On steel tower triangulation the observing parties usually send their Z's while it is still daylight. As it grows darker it will be necessary to moderate the light and an experienced lightkeeper will do this without being called. Later in the evening, as the cells grow weaker it may again become necessary to brighten the light and a good lightkeeper can tell when to do this.

Be sure to point accurately. If at any time, in changing a bulb or a lamp, there is reason to believe that you may have disturbed the pointing of your lights, call the observers in turn, starting with the bottom light, and re-point accurately, both horizontally and vertically. Often a violent gust of wind will change the pointings. Watch the pointings closely on a windy night.

Keep your lamps in good condition and the reflectors polished. A reflector which is dull on one side may cause an error in the observing.

Never use a heater of any kind on the tower or stand. Heat waves from the heater will cause the light to appear wavy to the observer.

Never have a lantern or fire around the tower or stand during the observing. The light may easily be mistaken for the signal light by the observer.

### ROUTINE WORK AT STATION

The routine work at a station differs slightly, depending on whether the station has a steel tower or a 4-foot stand.

At a 4-foot stand the following routine should be followed:

(1) Check plumbing of hole in which lights are screwed with a plumb bob. If this hole is not directly

over the mark, reset the board containing hole so that the light will be directly over the mark.

If a light stand is used over a 4-foot stand, use the hole made by the building party as you cannot plumb this distance accurately by yourself. The stand will be plumbed later by the observing party.

(2) Next locate the stations to which you will show. Do this as soon as possible. Orient your sketch by compass, taking into account the magnetic variation, or by a direction to some station you can see and identify. Do not jump at conclusions. Use every possible aid in orienting your sketch. When the country has section-line roads you can check your orientation by them. Towns shown on the sketch often assist in orienting. At least one to three stations can usually be recognized and used to assist in determining the directions to the others.

After finding the stations you should hold the directions to them by lines drawn on the stand or by stakes driven in the ground until you can verify them by seeing the lights. When you are on a wooded peak and there has been delay in seeing the observer's light, watch carefully for him, for the light may be obstructed close to your station and you may see it by standing up on the stand, by climbing a tree, or by walking some distance from the stand. In other words you cannot be absolutely sure the line is open unless you have seen a light from the other station, and unless you are sure keep trying to get the observer's call by watching very closely. When you fail to get the call, always watch the other stations closely for the observer you fail to get may be trying to send you a message through someone else.



When you are on a steel tower you will have no means of plumbing the line to the mark. Simply show your lights from the hole in the light plate on the top of the tower.

The above paragraphs regarding orienting your sketch hold true for a steel tower also except that you must be very careful in using a compass on a tower due to the attraction of the steel in the tower for the compass needle. You must stand up on the light-keeper's platform and hold the compass well above the steel in establishing a north line. Pick some point on the horizon as magnetic north and use that in orienting your sketch.

The *exact pointing of the light* on tower or stand is very important. The vertical pointing is just as important as the horizontal pointing. When you are adjusting your pointing on an observing party, brighten your light so that you can see the beam and sight above it to correct the horizontal pointing and hold your eye alongside the beam to check the vertical pointing. *If the light is not pointed exactly* to an observing party, they may be observing on a *portion of the reflector that is eccentric to the mark*, causing an error in the results.

If the observing party is working from a central camp you will be left at your station between 2 p. m. and 4 p. m. each day depending on the season and length of day. If your station is to be used as an initial by one of the observing parties, that observer will instruct you to show a light to him as soon as possible after reaching your station. It is very important for you to do this for it makes additional work for the observers to have to use a station other than their regular initial for obtaining their intersection stations or "cuts."

**Use of light-leveling plate.**—When showing more than two lights, and frequently when showing two, it will be found that the light plate is not exactly level, causing the lights to tilt out of plumb. In such cases an error in observing is caused by the observers pointing on an eccentric light. When this happens make use of your light-leveling plate under the bottom light and be sure to see that it is level by checking it in all directions with the small hand level which is provided for this purpose.

**Spelling of station name.**—When you arrive at a station you should examine the name stamped on the station mark and reference marks and see that the spelling is exactly the same as that shown on your sketch and reconnaissance description. If there is any difference, the spelling stamped on the marks should be signaled to each observing party after they have sent their Z's to you. For instance, if the station name shown on the print is "Schumaker" and the mark is stamped "Schumacher", you should send each observer the message, "Name Schumacher."

**Courtesy to the public.**—Whenever the property owner or occupant of land on which the station is located has any request or complaint to make, you must listen courteously and promise to call the matter to the attention of the observer, who will take it up with the chief of party. *Under no circumstances* must you bring up the question of pay for property damage. If the owner inquires about damages you should simply state that the complaint will be referred to the chief of party. This is of great importance.

Whenever anyone inquires as to the nature of the work, you should answer courteously and explain as well as time permits. By all means do not give any

wrong information intended to be humorous, and be sure to correct wrong impressions as to the reasons for the towers and lights. Whenever a question is brought up which you cannot answer, say frankly that you do not know. This is much better than giving an incorrect answer. The chief of party will probably have some pamphlets describing the work which he will give you to pass out to the public when they make inquiries.

**Driving truck.**—If you drive a truck your duties also extend to keeping your truck in good order. Grease your truck as frequently as necessary, and keep it clean and in good repair. Call the attention of the head mechanic or chief of party to anything wrong with your truck which you cannot repair yourself. Be sure to keep your truck record carefully. Make all required entries neatly and accurately.

Drive carefully. Remember that more field employees are discharged for poor truck driving than for any other cause. The chief of party studies records of truck costs and your chances for promotion may hinge on your ability as a truck driver.

**Cleanliness and sanitation.**—It is very important that camps always be kept in a clean and orderly condition. Keep camp grounds free of waste paper and rubbish and keep your tent clean and sanitary. Trucks should be parked in an orderly manner within the space designated by the chief of party. Toilets or toilet tents should be kept clean. Follow all instructions regarding use of lime, which will be provided.

The foregoing also holds with respect to a station site. Do not leave odd bits of lumber, papers, worn-out cells, or tin cans around a station.

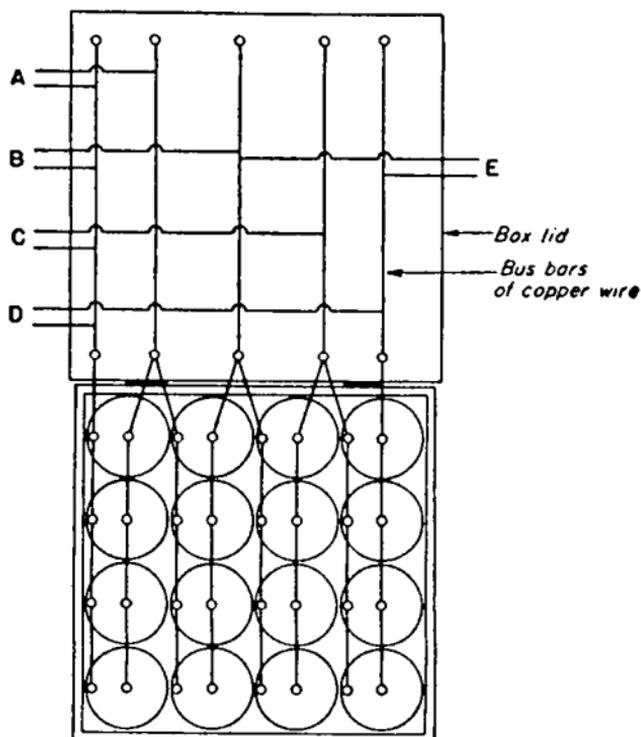
### SPECIAL EQUIPMENT AND ROUTINE ON LARGE PARTIES

At times large parties with from 3 to 6 observers have been operated and in special instances over short periods as many as 10 or 11 observers have worked simultaneously on the same night. When a party reaches this size unusual skill and careful handling of equipment is required of lightkeepers to avoid confusion and delay. On a party of this size you should be an extremely efficient signalman, as much time is wasted by poor signaling.

If required to show three or more lights you should build a battery box of the type shown in figure 7. This box contains 16 cells which are wired in parallel sets of 4 each. The box has a hinged cover with a series of bus bars on the under side of the cover. The box must be deep enough so that when the box is closed the bus bars will clear the tops of the cells by about 1 inch. The bus bars may be made of heavy copper wire, or if copper is not available, ordinary iron wire may be used. The wooden cover furnishes sufficient insulation if ordinary care against moisture is used and the bus bars may simply be screwed to the wooden cover. The short connections between the bus bars and the cells should be of the slip or U-type for ease in hooking up. With such a box the clips at the end of the lamp wires may be quickly clamped onto the bus bars.

**Lamp wiring.**—When three or more lights are shown, you should wire your lights so that they may be controlled from the observer's platform. Figure 8 shows the simplest method of such wiring. Each light is provided with a permanent ground wire from the screw socket in the bottom to the screw socket in the

top and is connected to one of the terminals on the lamp. When this is done only a single ground wire,



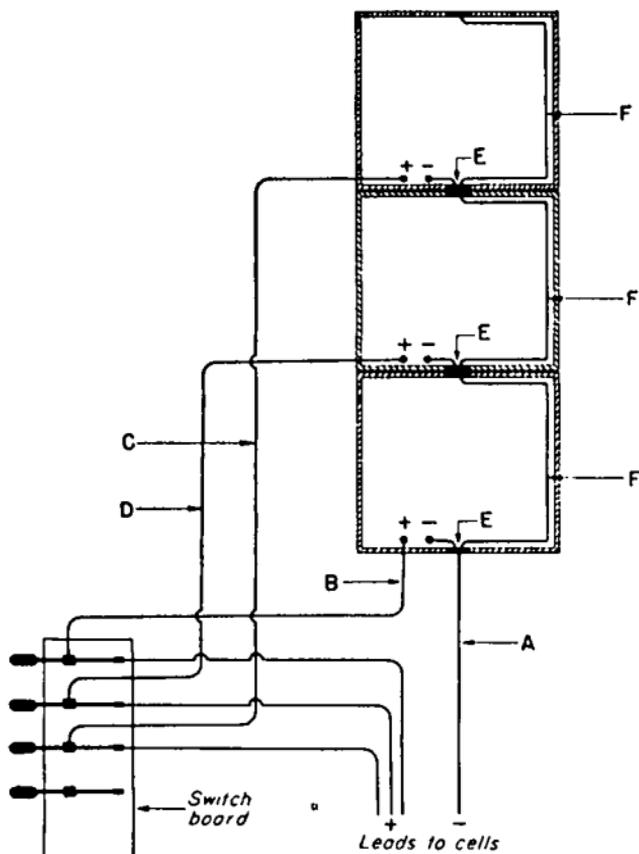
A-	Leads giving	15	volts
B-	"	30	"
C-	"	45	"
D-	"	60	"
E-	"	30	"

FIGURE 7.—Arrangement for battery box.

When lights must be shown to several observers at once a battery box like this is a great convenience.

A, from the battery need be used. The wires B, C, and D connect from the other terminal of each lamp to the other terminal of the battery, but run through the switchboard. The switchboard is fastened to one

of the legs of the tower on the observer's platform and has a single-throw knife switch for each lamp. The



*Ground wires "F" are connected to light screw sockets "E"*

FIGURE 8.—Arrangement of switches for several lights.

This switch board enables the light keeper to control each of several lights from the observer's platform.

advantages of this arrangement are many. You can signal or change voltage on lamps without climbing onto the light stand and only need to climb up to the

lights when it is necessary to change bulbs and correct the focus or the pointing of lights. The switches may be obtained in 5-and-10-cent stores and the switchboard is easily made. Each switch should be tagged with the designation of the party to which the light is being shown.

### MAKING PURCHASES

Occasionally in certain emergencies you will be authorized to make purchases. When this occurs be sure to have receipts properly signed and itemized or you will not be able to collect on the receipt from the chief of party.

Observe the following directions in detail:

1. Use subreceipt form no. 5.
2. Receipts must show purpose of expenditures unless it is plainly evident.
3. Use ink or indelible pencil in making out receipts.
4. Make all explanations in writing on face of the receipt.
5. Signatures by (X) are only to be made by persons unable to write their names. When made by (X) they must bear the name of the person and must be witnessed.
6. Separate and itemize all items and show all unit costs. This is most important. Carry out all extensions.
7. For hire of saddle horse, pack horse, or team, show number of days the horse or team was used, dates, and rate per day.
8. In sending a telegram to the chief of party, mark it "Official Government message" and send it "collect", and at the same time send a duplicate copy of the telegram by mail. Messages connected with the work and not addressed to the chief of party should be marked "Official Government business" and should be prepaid

and a *duplicate taken*, with the agent's receipt for the amount of money paid written on the face of the telegram. Government rates for telegrams are 40 percent of commercial rates based on commercial count but with minimum charges, as follows: Full rate day message, 25 cents; night message, 20 cents; night letter, 30 cents; day letter, 45 cents. Always indicate on the duplicate the kind of message sent (one of the four just mentioned).

9. Obtain full instructions from chief of party as to method of purchasing gasoline or oil as this changes frequently.

### SUMMARY

The foregoing instructions have been made very general. Considerable variations in procedure and methods occur on different parties, and the type of country in which you are working may also call for a different type of organization.

The fundamental rules of good lightkeeping, however, are always the same.

1. Know the code and be able to use it rapidly and efficiently.

2. Answer all calls promptly and reply intelligently, with fewest words needed to make the meaning clear.

3. Be thoroughly familiar with all your equipment and keep it in good condition.

4. Above all *get your light through*. The failure of one lightkeeper to show light properly and promptly may lose a day's time for the entire party.

5. Treat the public courteously.

6. Keep your camp sites clean and neat.

7. Cooperate fully with observing parties and other lightkeepers.

