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## APPENDIX A. No. 1.

*(Handed in by Sir Walter J. Howell, K.C.B.)*

EXTRACT FROM THE REGULATIONS FOR PREVENTING COLLISIONS AT SEA.

### 1. ORDER IN COUNCIL OF NOVEMBER 27, 1896.

SCHEDULE I.

*Preliminary.*

These Rules shall be followed by all vessels upon the high seas and in all waters connected therewith, navigable by sea-going vessels.

In the following Rules every steam vessel which is under sail and not under steam is to be considered a sailing vessel, and every vessel under steam, whether under sail or not, is to be considered a steam vessel.

The words "steam vessel" shall include any vessel propelled by machinery.

A vessel is "under way" within the meaning of these Rules, when she is not at anchor, or made fast to the shore or aground.

*Rules concerning Lights, &c.*

The word "visible" in these Rules, when applied to lights, shall mean visible on a dark night with a clear atmosphere.

ARTICLE 1. The Rules concerning lights shall be complied with in all weathers from sunset to sunrise, and during such time no other lights which may be mistaken for the prescribed lights shall be exhibited.

ARTICLE 2. A steam vessel when under way shall carry—

(*a*) On or in front of the foremast, or if a vessel without a foremast, then in the fore part of the vessel, at a height above the hull of not less than 20 feet, and if the breadth of the vessel exceeds 20 feet, then at a height above the hull not less than such breadth, so, however, that the light need not be carried at a greater height above the hull than 40 feet, a bright white light, so constructed as to show an unbroken light over an arc of the horizon of 20 points of the compass, so fixed as to throw the light 10 points on each side of the vessel, viz., from right ahead to 2 points abaft the beam on either side, and of such a character as to be visible at a distance of at least 5 miles.

(*b*) On the starboard side a green light so constructed as to show an unbroken light over an arc of the horizon of 10 points of the compass, so fixed as to throw the light from right ahead to 2 points abaft the beam on the starboard side, and of such a character as to be visible at a distance of at least 2 miles.

(*c*) On the port side a red light so constructed as to show an unbroken light over an arc of the horizon of 10 points of the compass, so fixed as to throw the light from right ahead to 2 points abaft the beam on the port side, and of such a character as to be visible at a distance of at least 2 miles.

(*d*) The said green and red side lights shall be fitted with inboard screens projecting at least 3 feet forward from the light, so as to prevent these lights from being seen across the bow.

(*e*) A steam vessel when under way may carry an additional white light similar in construction to the light mentioned in sub-division (*a*). These two lights shall be so placed in line with the keel that one shall be least 15 feet higher than the other, and in such a position with reference to each other that the lower light shall be forward of the upper one. The vertical distance between these lights shall be less than the horizontal distance.

ARTICLE 3. A steam vessel when towing another vessel shall, in addition to her side lights, carry two bright white lights in a vertical line one over the other, not less than 6 feet apart, and, when towing more than one vessel, shall carry an additional bright white light 6 feet above or below such lights, if the length of the tow, measuring from the stern of the towing vessel to the stern of the last vessel towed, exceeds 600 feet. Each of these lights shall be of the same construction and character, and shall be carried in the same position as the white light mentioned in Article 2 (*a*), except the additional light, which may be carried at a height of not less than 14 feet above the hull.

Such steam vessel may carry a small white light abaft the funnel or aftermast for the vessel towed to steer by, but such light shall not be visible forward of the beam.

ARTICLE 4. (*a*) A vessel which from any accident is not under command, shall carry at the same height as the white light mentioned in Article 2 (*a*), where they can best be seen, and, if a steam vessel, in lieu of that light, two red lights, in a vertical line one over the other, not less than 6 feet apart, and of such a character as to be visible all round the horizon at a distance of at least 2 miles; and shall by day carry in a vertical line one over the other, not less than 6 feet apart, where they can best be seen, two black balls or shapes, each 2 feet in diameter.

(*b*) A vessel employed in laying or in picking up a telegraph cable shall carry in the same position as the white light mentioned in Article 2 (*a*), and, if a steam vessel, in lieu of that light, three lights in a vertical line one over the other, not less than 6 feet apart. The highest and lowest of these lights shall be red, and the middle light shall be white, and they shall be of such a character as to be visible all round the horizon, at a distance of at least 2 miles. By day she shall carry in a vertical line one over the other, not less than 6 feet apart, where they can best be seen, three shapes not less than 2 feet in diameter, of which the highest and lowest shall be globular in shape and red in colour, and the middle one diamond in shape and white.

(*c*) The vessels referred to in this Article, when not making way through the water, shall not carry the side lights, but when making way shall carry them.

(*d*) The lights and shapes required to be shown by this Article are to be taken by other vessels as signals that the vessel showing them is not under command, and cannot therefore get out of the way.

These signals are not signals of vessels in distress and requiring assistance. Such signals are contained in Article 31.

ARTICLE 5. A sailing vessel under way, and any vessel being towed, shall carry the same lights as are prescribed by Article 2 for a steam vessel under way, with the exception of the white lights mentioned therein, which they shall never carry.

ARTICLE 6. Whenever, as in the case of small vessels under way during bad weather, the green and red side lights cannot be fixed, these lights shall be kept at hand lighted and ready for use; and shall, on the approach of or to other vessels, be exhibited on their respective sides in sufficient time to prevent collision, in such manner as to make them most visible, and so that the green light shall not be seen on the port side, nor the red light on the starboard side, nor,

if practicable, more than 2 points abaft the beam on their respective sides.

To make the use of these portable lights more certain and easy, the lanterns containing them shall each be painted outside with the colour of the light they respectively contain, and shall be provided with proper screens.

ARTICLE 7. Steam vessels of less than 40, and vessels under oars or sails of less than 20 tons gross tonnage, respectively, and rowing boats, when under way, shall not be obliged to carry the lights mentioned in Article 2 (*a*) (*b*) and (*c*), but if they do not carry them they shall be provided with the following lights:—

1. Steam vessels of less than 40 tons shall carry:
   (*a*) In the fore part of the vessel, or on or in front of the funnel, where it can best be seen, and at a height above the gunwale of not less than 9 feet, a bright white light constructed and fixed as prescribed in Article 2 (*a*), and of such a character as to be visible at a distance of at least 2 miles.
   (*b*) Green and red side-lights constructed and fixed as prescribed in Article 2 (*b*) and (*c*), and of such a character as to be visible at a distance of at least 1 mile, or a combined lantern showing a green light and a red light from right ahead to 2 points abaft the beam on their respective sides. Such lantern shall be carried not less than 3 feet below the white light.
2. Small steamboats, such as are carried by sea-going vessels, may carry the white light at a less height than 9 feet above the gunwale, but it shall be carried above the combined lantern, mentioned in sub-division 1 (*b*).
3. Vessels under oars or sails, of less than 20 tons, shall have ready at hand a lantern with a green glass on one side and a red glass on the other, which, on the approach of or to other vessels, shall be exhibited in sufficient time to prevent collision, so that the green light shall not be seen on the port side, nor the red light on the starboard side.
4. Rowing boats, whether under oars or sail, shall have ready at hand a lantern showing a white light, which shall be temporarily exhibited in sufficient time to prevent collision.

The vessels referred to in this Article shall not be obliged to carry the lights prescribed by Article 4 (*a*), and Article 11, last paragraph.

ARTICLE 8. Pilot vessels, when engaged on their station on pilotage duty, shall not show the lights required for other vessels, but shall carry a white light at the masthead, visible all round the horizon, and shall also exhibit a flare-up light or flare-up lights at short intervals, which shall never exceed fifteen minutes.

On the near approach of or to other vessels they shall have their side lights lighted, ready for use, and shall flash or show them at short intervals, to indicate the direction in which they are heading, but the green light shall not be shown on the port side, nor the red light on the starboard side.

A pilot vessel of such a class as to be obliged to go alongside of a vessel to put a pilot on board, may show the white light instead of carrying it at the masthead, and may, instead of the coloured lights above mentioned, have at hand ready for use a lantern with a green glass on the one side, and a red glass on the other, to be used as prescribed above.

Pilot vessels when not engaged on their station on pilotage duty, shall carry lights similar to those of other vessels of their tonnage.*

†ARTICLE 9.—Fishing vessels and fishing boats, when under way and when not required by this Article to carry or show the lights hereinafter specified, shall carry or show the lights prescribed for vessels of their tonnage under way.

(*a*) Open boats, by which is to be understood boats not protected from the entry of sea water by means of a continuous deck, when engaged in any fishing at night with outlying tackle extending not more than 150 feet horizontally from the boat into the seaway, shall carry one all-round white light.

Open boats, when fishing at night, with outlying tackle extending more than 150 feet horizontally from the boat into the seaway, shall carry one all-round white light, and in addition, on approaching or being approached by other vessels, shall show a second white light at least 3 feet below the first light and at a horizontal distance of at least 5 feet away from it in the direction in which the outlying tackle is attached.

(*b*) Vessels and boats, except open boats as defined in sub-division (*a*), when fishing with drift nets, shall, so long as the nets are wholly or partly in the water, carry two white lights where they can best be seen. Such lights shall be placed so that the vertical distance between them shall be not less than 6 feet and not more than 15 feet, and so that the horizontal distance between them, measured in a line with the keel, shall be not less than 5 feet and not more than 10 feet. The lower of these two lights shall be in the direction of the nets, and both of them shall be of such a character as to show all round the horizon, and to be visible at a distance of not less than 3 miles.

Within the Mediterranean Sea and in the seas bordering the coasts of Japan and Korea sailing fishing vessels of less than 20 tons gross tonnage shall not be obliged to carry the lower of these two lights; should they, however, not carry it, they shall show in the same position (in the direction of the net or gear) a white light, visible at a distance of not less than one sea mile, on the approach of or to other vessels.

(*c*) Vessels and boats, except open boats as defined in sub-division (*a*), when line-fishing with their lines out and attached to or hauling their lines, and when not at anchor, or stationary within the meaning of sub-division (*h*), shall carry the same lights as vessels fishing with drift-nets. When shooting lines, or fishing with towing lines, they shall carry the lights prescribed for a steam or sailing vessel under way respectively.

Within the Mediterranean Sea and in the seas bordering the coast of Japan and Korea sailing fishing vessels of less than 20 tons gross tonnage shall not be obliged to carry the lower of these two lights; should they, however, not carry it, they shall show in the same position (in the direction of the lines) a white light, visible at a distance of not less than one sea mile on the approach of or to other vessels.

(*d*) Vessels, when engaged in trawling, by which is meant the dragging of an apparatus along the bottom of the sea—

1. If steam vessels, shall carry in the same position as the white light mentioned in Article 2 (*a*), a tricoloured lantern so constructed and fixed as to show a white light from right ahead to two points on each bow, and a green light and a red light over an arc of the horizon from 2 points on each bow to 2 points abaft the beam on the starboard and port sides respectively; and not less than 6 nor more than 12 feet below the tricoloured lantern a white light in a lantern, so constructed as to show a clear uniform and unbroken light all round the horizon.

2. If sailing vessels, shall carry a white light in a lantern, so constructed as to show a clear uniform and unbroken light all round the horizon, and shall also, on the approach of or to other vessels, show where it can best be seen, a white flare-up light or torch in sufficient time to prevent collision.

All lights mentioned in subdivision (*d*) 1 and 2 shall be visible at a distance of at least 2 miles.

(*e*) Oyster dredgers and other vessels fishing with dredge nets shall carry and show the same lights as trawlers.

(*f*) Fishing vessels and fishing boats may at any time use a flare-up light in addition to the lights which they are by this Article required to carry and show, and they may also use working lights.

(*g*) Every fishing vessel and every fishing boat under 150 feet in length when at anchor, shall exhibit a white light visible all round the horizon at a distance of at least one mile.

Every fishing vessel of 150 feet in length or upwards, when at anchor, shall exhibit a white light visible all round the horizon at a distance of at least one mile, and shall exhibit a second light as provided for vessels of such length by Article 11.

Should any such vessel, whether under 150 feet in length, or of 150 feet in length or upwards, be attached to a net or other fishing gear, she shall on the approach of other vessels show an additional white light at least 3 feet below the anchor light, and at a horizontal distance of at least 5 feet away from it in the direction of the net or gear.

(*h*) If a vessel or boat when fishing becomes stationary in consequence of her gear getting fast to a rock or other obstruction she shall in daytime haul down the day-signal required by subdivision (*k*); at night show the light or lights prescribed for a vessel at anchor; and during fog, mist, falling snow, or heavy rain-storms make the signal prescribed for a vessel at anchor. (*See* subdivision (*d*) and the last paragraph of Article 15.)

(*i*) In fog, mist, falling snow, or heavy rain-storms, drift-net vessels attached to their nets, and vessels when trawling, dredging or fishing with any kind of drag-net, and vessels line fishing with their lines out, shall, if of 20 tons gross tonnage or upwards, respectively, at intervals of not more than one minute make a blast; if steam vessels, with the whistle or syren, and if sailing vessels with the fog-horn; each blast to be followed by ringing the bell. Fishing vessels and boats of less than 20 tons gross tonnage shall not be obliged to give the above-mentioned signals; but if they do not, they shall make some other efficient sound signal at intervals of not more than one minute.

(*k*) All vessels or boats fishing with nets or lines or trawls, when under way, shall in daytime indicate their occupation to an approaching vessel by displaying a basket or other efficient signal where it can best be seen. If vessels or boats at anchor have their gear out, they shall on the approach of other vessels, show the same signal on the side on which those vessels can pass.

The vessels required by this Article to carry or show the lights hereinbefore specified shall not be obliged to carry the lights prescribed by Article 4 (*a*), and the last paragraph of Article 11.

ARTICLE 10. A vessel which is being overtaken by another shall show from her stern to such last-mentioned vessel a white light or a flare-up light.

The white light required to be shown by this Article may be fixed and carried in a lantern, but in such case the lantern shall be so constructed, fitted, and screened that it shall throw an unbroken light over an arc of the horizon of 12 points of the compass, viz., for six points from right aft on each side of the vessel, so as to be visible at a distance of at least one mile. Such light shall be carried as nearly as practicable on the same level as the side-lights.

ARTICLE 11. A vessel under 150 feet in length, when at anchor, shall carry forward, where it can best be seen, but at a height not exceeding 20 feet above the hull, a white light in a lantern so constructed as to show a clear, uniform, and unbroken light visible all round the horizon at a distance of at least one mile.

A vessel of 150 feet or upwards in length, when at anchor, shall carry in the forward part of the vessel, at a height of not less than 20, and not exceeding 40 feet above the hull, one such light, and at or near the stern of the vessel, and at such a height that it shall be not less than 15 feet lower than the forward light, another such light.

The length of a vessel shall be deemed to be the length appearing in her certificate of registry.

A vessel aground in or near a fairway shall carry the above light or lights and the two red lights prescribed by Article 4 (*a*).

ARTICLE 12. Every vessel may, if necessary, in order to attract attention in addition to the lights which she is by these rules required to carry, show a flare-up light or use any detonating signal that cannot be mistaken for a distress signal.

ARTICLE 13. Nothing in these rules shall interfere with the operation of any special rules made by the Government of any nation with respect to additional station and signal lights for two or more ships of war or for vessels sailing under convoy, or with the exhibition of recognition signals adopted by shipowners, which have been authorised by their respective Governments and duly registered and published.

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## 2. ORDER IN COUNCIL OF 7TH JULY, 1897.

### SCHEDULE.

*Lights to be carried by Steam Pilot Vessels.*

A steam pilot vessel exclusively employed for the service of pilots licensed or certified by any pilotage authority or the committee of any pilotage district in the United Kingdom when engaged on her station on pilotage duty, and in British waters, and not at anchor, shall in addition to the lights required for all pilot boats, carry at a distance of eight feet below her white masthead light a red light visible all round the horizon, and of such a character as to be visible on a dark night with a clear atmosphere at a distance of at least two miles and also the coloured side lights required to be carried by vessels when under way.

When engaged on her station on pilotage duty and in British waters and at anchor, she shall carry in addition to the light required for all pilot boats the red light above mentioned, but not the coloured side lights.

When not engaged on her station on pilotage duty she shall carry the same lights as other steam vessels.

* *See also below* the Schedule to the Order in Council of the 7th July 1897, which deals with the lights to be carried by steam pilot vessels.

† From Order in Council dated 4th April, 1906.

## No. 2.

*(Handed in by Sir Walter J. Howell, K.C.B.)*

### Extract from the Board of Trade Instructions as to the Survey of Lights and Fog Signals.

*General.*

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11. *Application of Instructions.*—Lights fitted prior to 1896 need not comply in every detail with the following instructions, but no lights are to be passed if it is clear that they do not comply with the regulations, and it should be borne in mind that unless burners of good design, and lenses of good form and quality, and coloured slides, such as will not unduly obstruct the light are used, lamps may not show a light for the required distance.

12. *Electric Lights.*—Except where otherwise stated or where the context implies otherwise, the instructions relating to lanterns in which oil is burned apply equally to those in which the electric light is used. Oil lamps must always be provided in addition to fittings for electric light. In the case of masthead lights, owing to the difficulty of changing the fittings at sea, there must always be a separate lantern; in the case of side lights the provision of separate lanterns should be encouraged as much as possible, but if the owners supply lanterns with alternative fittings, they should not be objected to if the requirements as to position of the light, screening, colour of lens, ventilation of lantern, &c., are fully complied with.

The power of the masthead light should not be such as to give it the character or appearance of a shore light; a white light, if too strong, may be misleading and a source of danger to approaching ships.

All incandescent electric lights should be examined to see that the candle power has not been unduly reduced by the blackening of the bulb, or otherwise.

13. *Acetylene.*—There is nothing in the collision regulations to prevent the use of acetylene gas for ships' lights, provided the lights are in all respects such as are required by the regulations, and proper precautions are taken with regard to the storage and use of the carbide of calcium. Unless, however, it can be shown that the lamps are thoroughly reliable, oil lamps should be provided in addition, and the surveyors should see that these comply with the regulations.

*Side Lights.*

14. *Lanterns.*—The width of the back and side of the lantern should not be less than nine inches, and the height should not be less than eleven inches.

The passages for the admission of air to the interior of the lantern should have ample area, and be so arranged that the flame of the lamp will not be extinguished or caused to smoke by the wind or motion of the vessel in rough weather. The lantern should be constructed in such a manner as to preclude the possibility of spray or broken water obtaining access to its interior in such quantity as to interfere in any way with the efficiency of the light.

The arm or bracket by which the lantern is clamped to the screen should not be less than $\frac{3}{4}$ inch in thickness by two inches in breadth; it should be a fairly good fit in the socket of the lantern, and be secured in such a manner that the tightening of the clamping screw will bring the side of the lantern parallel with the side of the screen. The clamping screw should be brass, T-shaped, and not less than $\frac{3}{4}$ inch in diameter, or preferably the lantern should be cleated to the screen top and bottom.

15. *Lenses.*—The lenses should be made of crown or flint glass, highly polished, and free from air-bubbles or other visible defects. Plano-convex and dioptric lenses should be made as thin as practicable consistently with efficiency and durability.

In order to insure the light being equally visible at all the required angles, it is desirable—

(1) that the lense should be the arc of a circle, and

(2) that the radius which describes it should be measured from the centre of the flame, so as to insure the latter being horizontally equidistant from every part of the lens. The length of the radius may be ascertained from the formula:

$$\frac{\frac{a^2}{v}+v}{2}=r.$$

Where $a$ = half the chord of any portion of the arc.
$v$ = the versed sine corresponding to that chord.
$r$ = radius.

The lens should embrace an angle of not less than 120°, and its height must, in no case, be less than the length of the radius.

The curvature of the outer face of plano-convex lenses and of the respective parts of the outer face of dioptric lenses should be such as to give the desired concentration of the rays of light, subject to the condition that the light must be visible in a clear atmosphere on a dark night at a distance of at least one sea mile, when the lamp is heeled 20° either above or below the horizontal plane.

In sailing vessels and fishing smacks, from 10° to 15° would be sufficient, but as there is no difficulty in manufacturing lamps which shall have a vertical divergence of 20° and still show the distance required by the regulations, it is desirabie that they should all be uniform in this respect.

Lenses having vertical corrugations or ridges on their inner surfaces are objectionable, as the effect of these corrugations is to cut up and obstruct the light and to rob the coloured lights of their distinctive colour when seen from certain positions. These lenses should, therefore, not be passed in the case of side lights.

Lenses of unusual pattern, unless they have been already approved, should, in all instances, be submitted to the Board.

Side lights, unless supplied and passed before the 1st May 1901, should not be allowed if fitted with vertical metal bars on the face of the lens.

16. *Colour.*—It is important that side lights should be of the right shade of colour, and patterns of red and green glass of two different tints have been sent to each district for the guidance of the Surveyors. A special shade of green has also been sent for electric lights.

In the case of oil lamps, lenses, or slides of the same tint as either of the standard glasses or of any intermediate tint may be passed as regards colour.

In the case of electric lights, the use of lamps of more than 32 candle power should be discouraged, as they may affect the colour. The proper shade of green will probably lie between the darker of the two standard tints and the special electric tint; red lenses or slides of the darker of the two standard tints or of a shade intermediate between the two colours will be found to give a good colour.

In all cases a practical test should be made to determine the colour, and as slides and lenses of good colour may be defective transmitters of light, the surveyor should be satisfied that the lights have the required visibility. If possible, the lights should be compared, both as regards colour and visibility, with lights which are known to comply with the regulations.



Lenses coloured throughout absorb much of the light, and should be discouraged; lenses which have a film of colouring matter on the inside surface only have also frequently been found not to be satisfactory; and white lenses with good coloured glass slides behind them are, in all cases, to be preferred. Coloured chimneys should not be passed.

17. *Coloured Slides.*—Suitable means should be provided for keeping the coloured slides in their proper position, and for preventing the door of the lantern being closed when the slide is displaced. Provision should also be made to prevent the port and starboard slides being interchanged, and lights in which the green and red slides are interchangeable should not be passed. A spare set of slides should be provided for each pair of lights, and it is desirable that all slides should, whenever possible, be set in a metal mounting to prevent breakage.

18. *Cisterns.*—The cistern of the lamp should contain sufficient oil to last for at least 16 hours; it should not intercept any of the rays that would otherwise fall on the lower half of the lens; and its height should be such that the most luminous part of the flame will be level with the centre of the lens. The centre of the wick, or system of wicks, should coincide with the centre of curvature of the inner face of the lens; and the base of the lamp should be so arranged, constructed, and fitted in the lantern as to render it practically impossible for the lamp to be accidentally or carelessly placed in, or to shift to, any position other than that which it would occupy when the foregoing conditions are fulfilled.

When two lamps, one for paraffin and the other for colza, are supplied with a lantern, the base plate of the lamps should be alike, and should occupy the same position in the lantern when the lamps are in their proper place. Lanterns with means for placing the lamps at different heights should not be passed. The same lamp should not be passed for both paraffin and colza.

19. *Wicks.*—Where single flat wicks are used, they should in the case of paraffin lamps be not less than 1 inch, and in the case of colza lamps not less than $1\frac{1}{4}$ inches, nor more than 2 inches, in breadth measured at right angles to the fore-and-aft line of the ship. The wick-holder in the case of 1-inch single flat wicks must always be at right angles to the fore-and-aft line of the ship. In the case of wicks of greater breadth than 1 inch, the wick-holder may be placed at any angle desired, so long as the breadth, when measured at right angles to the fore-and-aft line of the ship, is not less than 1 inch nor more than 2 inches. Means should be provided for preventing the wick-holder from being accidentally or carelessly put in, or moved to, any other position than that required by this instruction. The same rule should be followed in the case of the filaments of electric lights, the breadth of the filaments being taken as between the extreme edges of their curves.

Circular wicks have been found to give good results in oil and paraffin lamps, and wicks of this description for use in paraffin lamps may be accepted if they are not less than $\frac{7}{8}$ inch diameter outside. Duplex burners, if of an efficient pattern, have the same effect as circular wicks, and may be so regarded.

Corduroy wicks have been tested and found unsatisfactory, and should not be passed by the Surveyors.

20. *Chimneys.*—In the case of paraffin lamps the use of glass chimneys, either of the ordinary or improved cone form, is strongly recommended, as it has been found that ordinary wedge burners without chimneys do not in many cases show a light for the distance required by the collision regulations. When chimneys are not fitted, special steps should be taken to see that the required range of light is obtained. Ordinary wedge burners, if only 1 inch wide, should not in future be passed in new lamps unless it is demonstrated by actual trial that the light will be visible for the required distance. Chimneys should be of plain white glass of the best quality and form, and there should be at least five spare ones on board for each lamp carried. As stated above, coloured chimneys should not be passed for side lights.

21. *Reflectors.*—A substantial metal spherical reflector, silver-plated and highly polished, should be fitted to each lamp. Its horizonal axis should be in the same plane as the horizontal axis of the lens, and the radius which describes the arc should be measured from the centre of the flame, the length of the radius being ascertained in the same manner as that of the lens, *i.e.*,

$$\frac{\frac{a^2}{v}+v}{2}=r.$$

If these instructions are complied with, the centre of curvature of the lens, the centre of curvature of the reflector, and the centre of the flame will coincide.

The reflectors should not be so small that a line drawn from any part of the lens through the centre of the flame will fail to fall on their surface, and they should never be so large as to intercept any of the direct rays falling on the lens.

Means should be provided for preventing the lamp from being placed in the lantern with the reflector shipped, but not in its proper position.

22. *Screens.*—The screens of side lights, the length of which should never be less than 36 inches from the flame to the chock or its equivalent, are always to be placed parallel to the line of keel, and the lights so screened that the forward edge of the screen, or chock on it, shall be in a line parallel to the keel with the inside edge of the wick. In the case of electric lights, there should be a similar screening to the inside edge of the filament. Where the source of light is less than 1 inch in width, as in the case of some circular, duplex, or acetylene burners, the forward edge of the screen or outer edge of the chock should be in a line parallel to the keel with a point measuring 1 inch inboard from the outside edge of the wick, system of wicks, or flame. The screens may be fitted as shown in Plates I. and II.* If more than one set of side lights are provided, the Surveyors should see that the position of the wick-holder is the same in each set, so that the screens as fitted will in each case be suitable. Should there be any difficulty in having this instruction carried out, the case should be reported to the Board of Trade.

When the screens are of wood, they should be well seasoned, and not less than $1\frac{1}{4}$ inches in thickness; the chock should be at least 2 inches in thickness, and rounded off, as shown in Figs, 3 and 4, Plate I.*

The screens are never to be secured to the rigging except in the cases referred to in paragraph 27; when the screens are attached to movable davits or to outriggers extending outwards over the sides of the vessel, they should be fitted with stop pins or distance rods, so contrived and arranged that when the stop pins are in their places the screens will be parallel with the middle line of the vessel.

The davits or stanchions for supporting the screens should in all cases be of a very substantial character and well fitting, and when they go through the top-gallant or main rail they should be carried down into sockets on the covering board or waterway, and have a nut or cotter under the rail to keep them in position.

The screens should be so placed that the lights as screened will not be obscured by any of the equipments of the vessel, such as catheads, boats, boats' davits, sails, rigging, &c., or by passengers or crew moving or standing forward of the lights. To insure this, the lights should be placed as far forward as practicable, and in vessels of very fine entrance, where it may not be possible to carry them far forward, great care should be taken to see that the lamps are so placed that their rays cannot be intercepted by persons standing or moving about on board. Unless the lights are of a sufficient height above the deck to protect them in this respect, either their height should be increased or they should be placed on properly constructed outriggers at the necessary distance outboard of the vessel. Surveyors are to do their best to insure the side lights of all vessels of 200 tons or over being carried well forward of the midship section of the ship.

* Not printed.

23. *Setting of Lens with reference to Wick.*—In order to prevent the light from being obstructed by the portion of the lantern which extends over the inner edge of the lens, the Surveyors should see that the lens is so set in the lantern that the rays from the inner edge of the wick pass through the lens, and cut the outer edge of the chock. To insure this, it is desirable that the setting of the lens should be well clear of the line between the inner edge of the wick and the outer edge of the chock.

To provide for the unbroken light being visible for two points abaft the beam, the construction of the lantern should be such that a line drawn from the after edge of the wick in the direction of two points abaft the beam cuts the edge of the setting of the lens. Should the wick be placed at right angles to the fore-and-aft line of the ship, then the above line should be drawn from the inner edge of the wick.

Plate III. illustrates the requirements of this clause.*

24. *Light-towers.*—Lights which are mounted in light-towers should be carefully inspected, and in the case of new vessels any requisite alterations should be suggested by the Surveyors before their construction is too far advanced. The light-towers should be as far forward in the ship as may be practicable, and if the lights are not then clear of all possible obstructions, the height of the towers must be increased as may be necessary.

Facilities should be provided by means of 1½-inch holes, or other apertures, in the light-towers for direct measurement from the wick to a line parallel to the middle line of the ship for the purpose of properly adjusting the screens.

The windows of towers should be made of white glass of the best quality, and should be of such dimensions as to admit of the lights showing in the manner required by the regulations.

Windows consisting of several panes are undesirable, but may be passed if the mullions are set at an angle of 45° from the vertical and do not exceed ⅜ of an inch in width.

In cases, however, where the lamps have more than one wick, the width of the mullions may be somewhat greater, and their angle from the vertical may be decreased.

To enable lights in towers to show the two miles required by the regulations, they will generally require to have greater illuminating power than those carried in the ordinary manner.

If the Surveyors should find tower windows of unusual construction, or such as to lead them to believe that the lights would not be visible at the distance and in the direction required by the regulations, a test should be made, and full particulars of this and of the lights and windows should be submitted to the Board for consideration.

25. *Gimbals.* — When side lights are hung on gimbals, the points of suspension of the latter should be in the same horizontal plane as the centre of the lens, in order that the angle at which the most convergent rays cross each other may be practically constant.

26. *Oscillating Screens.*—The oscillating screens shown in Plate IV.* are considered preferable to gimbals, except for vessels in which the change of fore-and-aft trim is exceptionally great. When the lamps are carried either by gimbals or oscillating screens the dioptric concentration of the rays by means of the lenses may be carried to a greater extent than is necessary for fixed lamps.

27. *Lights in the Rigging.*—In the case of small sailing vessels which cannot with safety and convenience of working carry their side lights on stanchions, the lights may be carried in the rigging, provided the Surveyors are satisfied that they are so fitted as to show for the distance and in the direction required by the regulations. This is not to be allowed in the case of steamers.

* Not printed.

*Masthead, Anchor, Stern, and other Lights.*

28. *Masthead Lights.*—Care should be taken to see that proper fittings are provided for the masthead light on or in front of the foremast on an independent stay, fitted with a fork and a piece of metal tube running up the stay to carry the fork; and that the light will show for the distance and in the direction required by the regulations. If sails are carried the Surveyor should be satisfied that the light will not be obscured when the sails are set.

The height of the masthead light above the hull should be measured from the weather deck, *i.e.*, the uppermost deck forming the boundary of the hull or underdeck tonnage.

The rules regarding the oil cisterns, wicks, wick-holders, and position of the luminous part of the flame of side lights apply to masthead lights, except that the wickholder need not be fixed to present the light at right angles to the fore-and-aft line of the ship; such an arrangement is, however, desirable.

Masthead lights, unless supplied and passed before May 1st, 1901, should not be allowed if fitted with vertical metal bars of a greater diameter than one-eighth of an inch in front of the lens.

Masthead lights should be fitted with reflectors. The Surveyors should, however, be careful to see that they are not of such size and form as to intercept any of the direct rays of light which should fall upon the lens.

The power and character of a masthead light should not be such as to give it the appearance of a shore light.

29. *Anchor lights.*—The diameter of the lenses of anchor lights should not be less than eight inches, and if provision is made for burning both colza and paraffin oil, separate cisterns should be provided, care being taken to see that the burners and cisterns are not interchangeable, and that the centre of the flame is in each case at the same height as the centre of the lens.

Vessels whose registered length is 150 feet or upwards must be provided with two anchor lights for use together, and in such cases it is desirable that the same description of oil should be used in both lamps, and that the internal portions of both should be alike in all respects.

The wicks of anchor lights should not be less than 1¼ inches broad for colza oil and ⅞ inch for paraffin.

30. *Stern lights.*—The wicks of stern lights should not be less than 1¼ inches broad for colza oil and ⅞ inch for paraffin.

The rules regarding the oil cisterns and reflectors of side lights apply equally to stern lights.

31. *Not-under-command lights.*—The two red lights prescribed by Article 4 of the collision regulations for the use of vessels which are not under command are required to be visible for the same distance as side lights, viz., at least two miles.

The wicks of these lamps should in no case be smaller than those specified for side lights, and, as reflectors cannot be fitted, wicks of greater width than the minimum laid down in paragraph 19 will be required unless the lenses and burners are of superior design and quality.

The lenses may be either spherical or cylindrical. No special size need be insisted on, but if the diameter is less than ten inches, the Surveyors should take steps to satisfy themselves that the ventilation of the lantern is sufficient to prevent it from becoming unduly heated.

The colour of the lenses or coloured slides, if the latter are used, should not differ materially from that required for the port side light.

32. *Lights of small vessels.*—In the case of vessels coming under Article 7 of the regulations, the standard size of lamp need not be insisted on, provided the lamps supplied comply with the collision regulations, and are of such size as to afford sufficient ventilation and to continue burning without undue heating.



## No. 3.

*(Handed in by Sir Walter J. Howell, K.C.B.)*

COPY OF THE ORIGINAL INSTRUCTIONS, ISSUED BY THE BOARD OF TRADE IN JANUARY, 1877, TO EXAMINERS FOR MASTERS' OR MATES' CERTIFICATES WITH REGARD TO COLOUR-BLINDNESS.

Cases occur of persons who suffer from what is termed Colour Blindness, *i.e.*, from an inability to distinguish certain colours.

The Board of Trade have, therefore, decided that all candidates for examination for masters' or mates' certificates shall pass a test examination as to their ability to distinguish the following colours, which enter largely into the combinations of signals by day or night used at sea; namely, black, white, red, green, yellow, and blue.

The Examiners will be furnished with cards and glasses of these several colours, and before proceeding to the regular examination of the candidate, they must satisfy themselves that he is able to distinguish correctly each of the colours referred to.

In the event of his failing to do so, in even one of these colours, the Examiner must decline to proceed to the regular examination, and must forward to this Board a special report of the case.

The Board have been led to this decision because of the serious consequences which might arise from an officer of any vessel being unable to distinguish the colours of the lights and flags which are carried by vessels.

(Signed) EDWARD STANHOPE,
Secretary.

(Signed) THOMAS GRAY,
Assistant Secretary.

## No. 4.

*(Handed in by Sir Walter J. Howell, K.C.B.)*

COPY OF INSTRUCTIONS ISSUED BY THE BOARD OF TRADE TO THEIR EXAMINERS IN 1885.

[*Figures showing the Luminosity and Wave Length of the Colours used are inserted from the Report of the Committee of the Royal Society on Colour Vision*, 1892.]

Board of Trade,
Marine Department,
March 1885.

INSTRUCTIONS TO EXAMINERS.

*Examination in Colours.*

Herewith are—

(*a*) A lanthorn having in it a lamp in which kerosine is to be burnt.

(*b*) A slide having ground glass in it.

(*c*) Nine slides, each having a coloured glass in it. The colours are as follow:—

| | Luminosity in Gas-light, white, 100. | Dominant Wave Length. |
|---|---|---|
| 1. Red (Standard) | 11·2 | 6,200 |
| 2. Pink or salmon | 42·5 | — |
| 3. Green (Standard or No. 1). | 10·0 | 5,190 |
| 4. Green (Bottle or No. 2). | 5·7 | 5,720 |
| 5. Green* (Pale or No. 3). | 20·0 | — |
| 6. Yellow | 80·0 | — |
| 7. Neutral.* | 7·5 | — |
| 8. Blue (Standard) | 2·5 | 4,650 |
| 9. Blue* (Pale) | 7·5 | — |
| (*d*) Cards, five of each as follow:— | | |
| 1. White | 100 | — |
| 2. Black | 40 | — |
| 3. Red | 140 | 6,150 |
| 4. Pink* | 21 | 6,630 |
| 5. Green | 240 | 5,370 |
| 6. Drab* | 16·5 | 5,770 |
| 7. Blue | 7·5 | 4,750 |
| 8. Yellow | 8·0 | 5,620 |

*Examination by Daylight.* (*Cards.*)

In conducting the examination by daylight the examiner should do it in three ways.

1. The cards should be mixed up. The examiner should then hold up each card separately and ask the candidate to name the colour, and if the candidate does so without hesitation he is to be regarded as having passed the daylight test.
2. If the candidate hesitates in any of his answers so as to raise a doubt in the mind of the examiner as to his ability to readily distinguish colours, the examiner should put all the cards on the table and require the candidate to select all cards of a colour or colours named by the examiner.
3. Having done that they should all be mixed up again and the candidate should be required to sort the cards into eight heaps, putting all of one colour into each heap.
4. The result of the examination should be noted and recorded in each case.

*Examination by Artificial Light.*

The room should be dark.

The lamp lighted and placed in the lanthorn.

The applicant should be seated or should stand so as to be opposite to the opening of the lanthorn: and at least 15 feet from the front of the lanthorn.

He should first of all see the light in the lanthorn without the interposition of any glass and be asked if it appears to him to have any colour, and if so, what colour.

The slide with the ground glass should then be put into the opening at the front of the lanthorn which is nearest to the light, and the applicant asked the same question.

The slide with the ground glass is to be left in, and the slides with the coloured glasses placed one by one and separately in front of it, and the candidate asked in each case to name the colour or tint.

The result of the examination should, of course, be noted and recorded in each case.

*General.*

The cards and glasses against which a star * is placed in the list are what may be called confusion tints. The candidate is not to be regarded as having "failed" if he miscalls these tints, provided that he names all the others correctly. But if, having named all the other correctly, he miscalls these so far as to name the drab card No. 6 as red, pink, salmon, &c.; or to name card No. 7 as red, green, or yellow; or glass No. 2 as green, blue or yellow; or glass No. 5 as red, pink, salmon, &c.; or glass No. 7 as bright red or bright green; or the plain ground glass any colour, the case should be reported for record. In short, if the candidate's perception or impression of these tints does not agree with the perception of the examiner, the case should be reported on the form Exn. 17B.

The only reasons for which a candidate is to be reported as having failed are inability to distinguish red from green, or either from black, by daylight; and red from green, or either from the ground glass, by artificial light.

If a candidate fails in the the colour test when the ground glass is in the lanthorn (as it is always to be when the the coloured glasses are shown), he may also be tried over again with the coloured glasses without the intervention of the ground glass, and the result noted and recorded.

T. H. FARRER,
Secretary.

THOMAS GRAY,
Assistant Secretary.

*M.* 2,450.
1885.

## No. 5.

*(Handed in by Sir Walter J. Howell, K.C.B.)*

COPY of INSTRUCTIONS ISSUED BY THE BOARD OF TRADE TO THEIR EXAMINERS IN 1895.

Board of Trade,
Marine Department,
May 1895.

### INSTRUCTIONS TO EXAMINERS.

FORM AND COLOUR VISION TESTS.

(1) The Board of Trade have decided that, for the present, all cases of failure to pass the Form Vision test (*see* Note A. of the Regulations, Exn. 1, Appendix T.), due to *short sight* only, and not arising from loss of form sense accompanying colour-blindness induced by disease or injury, are to be submitted to the Principal Examiner of Masters and Mates, London, for special consideration, and that the local Examiner must await his instructions before returning a Candidate as failed.

(2) To enable the Examiner to distinguish whether the defective Form Vision is due to short sight only, or is induced by disease, boxes of pellets will be supplied, by which all Candidates who fail to pass the Form Vision test are to be examined. Instructions for conducting this examination are given below.

(3) Should the Candidate pass the pellet test, the Form Exn. 17B, together with the remarks of the Examiner, is to be forwarded to the Principal Examiner for his instructions as to whether the Candidate is or is not to be regarded as having failed in Form Vision.

(4) Should, however, the Candidate fail in the pellet test, thus indicating that the defectlve form sense is due to disease, &c., it will not be necessary to submit the case to London, but the Examiner should report the Candidate as having failed in Form Vision as at present, and in forwarding the usual papers a description of the colours of the pellets incorrectly selected as matches in the respective tests, with any remarks, should be given on the Form Exn. 17C, in the space allotted for the incorrect wools.

*Instructions for conducting the Pellet Test.*

The pellet test is to be conducted in exactly the same manner as the test by Holmgren's wools (*see* Note B. of Regulations, Exn. 1, Appendix T.):—

(1) A box of pellets of the same colours as most of the skeins of wools will be supplied amongst which will be test pellets, corresponding to the three test skeins, and of the same shade and colour, These will not be marked, but are easily distinguishable.

(2) The pellets should be placed on a white plate, and the first test pellet should then be placed a little distance from the box on another white plate. The Candidate should be required to pick out and lay by the side of the test pellet, all pellets of the same colour. The same should be done with the second and third test pellets, and the examination should proceed in the same way as the wool test.

COURTENAY BOYLE.
Secretary.

INGRAM B. WALKER,
Assistant Secretary.

*M.* 3528
1895.

## No. 6.

*(Handed in by Sir Walter J. Howell, K.C.B.)*

EXTRACT FROM THE REGULATIONS RELATING TO THE EXAMINATION OF MASTERS AND MATES IN THE MERCANTILE MARINE.

SIGHT TESTS.

27. Every candidate for a certificate of competency of any grade must pass the three sight tests before he can proceed to the examination in navigation and seamanship.

(1) The sight tests are open to all persons serving or intending to serve in the Mercantile Marine, and all such persons are recommended to take the earliest opportunity of ascertaining by means of these tests whether their vision is such as to qualify them for service in that profession.

(2) The three tests are:—

(*a*) Form vision test.
(*b*) Colour vision test.
(*c*) Colour ignorance test.

No candidate will be examined in the colour vision test until he has passed the form vision test, or in the colour ignorance test until he has passed the colour vision test.

This rule must be observed whether the candidate has or has not on any previous occasion passed the sight tests.



(3) Any person serving or intending to serve in the Mercantile Marine, if desirous of undergoing the form vision, colour vision, and colour ignorance tests *only*, must make application to the Superintendent of a Mercantile Marine Office on the form Exn. 2A, and must pay a fee of one shilling.

This fee will be payable on each occasion upon which a candidate is examined in form vision and colour tests.

(4) Candidates who fail to pass the form vision test or colour ignorance test can be re-examined at intervals of three months, but candidates who fail to pass the colour vision test cannot be re-examined. It is open, however, to any candidate who has failed to pass the colour vision test to appeal to the Board of Trade, who may, if they think fit, remit the case to a special examiner or body of examiners for final decision.

(5) The expenses of candidates who are examined by such special examiner or body of examiners, and are reported by them to have passed, will under certain circumstances, be paid by the Board of Trade, at a rate which will be notified to the candidates; but no payment whatever will be made towards the expenses of candidates who, upon their own application, are examined by the special examiners, and are reported by them to have failed, unless the Board of Trade consider that the particular circumstances of the case justify such payment. The special examinations will be held in London only.

(6) When a candidate fails to pass the colour vision test, the examiner will point out to him the conditions under which he can appeal. Appeals are to be made through the examiner, and forwarded to the Board of Trade with the examiner's remarks.

(7) The fee paid for examination for a certificate of competency includes the fee of one shilling for examination in form vision, colour vision and colour ignorance, and if the candidate fails to pass those tests, this fee will, with the exception of one shilling, be returned to him.

(8) Only examiners who have themselves passed the colour vision test are to undertake these examinations.

(9) Whenever the holder of a certificate of competency fails to pass any of the three tests, there is reason to believe that he is from incompetency unfit to discharge his duties, and in the public interest the Board of Trade may cause an Inquiry to be held by a Court, having jurisdiction to cancel or suspend such certificate; but in the alternative, the Board of Trade may accept the voluntary surrender of the certificate until such time as the applicant succeeds in passing the test in which he failed.

28. The Board of Trade have decided that on and after January 1st, 1914. the standard of form vision in the sight tests shall be raised to that specified in Appendix O on page 122, subject to the condition that candidates who, before the above date, shall have obtained any certificate of competency as Master or Mate (foreign-going or home trade), shall have the option of undergoing the present tests and shall not, in order to obtain certificates of higher grades, be required to pass the more severe test.

From November 1st, 1909, it will be possible for any person serving or intending to serve in the Mercantile Marine to be examined with reference to the higher standard, and if he passes, he may receive a certificate to that effect, or if he holds a certificate of competency, the fact of his having passed the higher standard may be endorsed upon it.

The examiners should in all cases point out to boys and others coming up for the Sight Tests that unless they are in possession of a certificate of competency by the 1st January, 1914, they will after that date be required to pass the new standard of Form Vision as laid down in Appendix O, whether they are coming up for a certificate of competency or for examination in the Sight Tests only.

## APPENDIX O.

THE SIGHT TESTS.

These tests must be conducted under the strict personal supervision of the examiner. A careful record must be kept of all mistakes made by the candidate in the form vision test, and on *no account whatever* must a candidate be allowed to make his selections in the colour vision test during any temporary absence of the examiner.

Each examiner must keep a record of all candidates passed by him for reference when required.

1.—*Form Vision Test.*

(1) *Test for form vision to be passed first.*—The test for form vision is the first test which the candidate is required to undergo, and until he has passed this test he cannot be allowed to proceed further with the examination.

(2) *Tests to be used.*—The test to be used is the letter test on Snellen's principle, for all candidates.

The sets of tests which have been supplied to the examiners consist of eight sheets of letters.

(3) *Object of the tests.*—The chief object of the tests for form vision is to show whether the candidate possesses eyesight of sufficient strength and acuity, or in other words they are means of discovering whether the candidate has good or bad sight.

They also afford a means of detecting whether a candidate is suffering from that form of colour blindness which is caused by the excessive use of tobacco, and by illness or similar affections. All candidates who are suffering from colour blindness arising from causes of that nature will be found to be incapable of passing the test for form vision.

(4) *General conduct of the tests.*—Candidates will be tested with each eye separately, and they must not be allowed to use spectacles or glasses of any kind.

The set of tests is to be hung on the wall in a *good light*, at a height of about five or six feet from the ground.

(5) *Conduct of the letter test.*—The candidate should be placed at a distance of exactly 16 feet from the letter test sheets and exactly opposite them. The distance should be carefully measured, and never varied under any circumstances whatever.

One of the eight sheets of letters should then be exposed, and the candidate should be asked to read the letters, beginning at the top and going downwards. If he can read correctly nine of the twelve letters in the sixth line from the top and eight of the fifteen letters in the seventh line with one eye, and the whole of the eight letters in the fifth line with the other eye, he may be considered to have passed the test. If he cannot do so his case should be submitted to the Principal Examiner of Masters and Mates.

(6) All candidates must be tested with at least two sheets of letters, viz., one to each eye, and the order of the test sheets must be varied with different candidates. In cases of candidates failing to reach the required standard, they should be tested with at least eight sheets, viz., four to each eye, and the result noted on the Form Exn. 17 B.

(7) *Tests to be varied.*—The examiner must take care, by varying the test sheets in form vision, and by every other means, to guard against the possibility of any deception on the part of the candidates.

(8) *Pellet test.*—Every candidate who fails to pass the form vision test is to be examined with the pellet test as follows:—

The pellets should be placed on a white plate, and the first test pellet (which is of the same colour as the first wool test skein) should then be placed a little distance from the box on another white plate. The candidate should be required to pick

out and lay by the side of the test pellet, all pellets of the same colour. The same should be done with the other test pellets, and the examination should proceed in the same way as the wool test.

(9) Should the candidate pass the pellet test, the Form Exn. 17 B, properly filled up, together with the remarks of the examiner, is to be forwarded to the Principal Examiner for his instructions as to whether the candidate is or is not to be regarded as having failed in form vision.

(10) Should, however, the candidate fail in the pellet test, thus indicating that the defective form sense is due to disease, &c., it will not be necessary to submit the case to London, but the examiner should report the candidate as having failed in form vision, and in forwarding the usual papers a description of the colours of the pellets incorrectly selected as matches in the respective tests, with any remarks, should be given on the Form Exn. 17 C, in the space allotted for the incorrect wools.

(11) *Result of tests to be reported.*—The result of every test in form vision is to be reported to the Registrar-General of Seamen on the Form Exn. 2, and to the Principal Examiner of Masters and Mates on the Form Exn. 14, when the candidate is up for examination for a certificate: and to the Registrar-General of Seamen on the Form Exn. 2 A. when the candidate is up for examination in colours only.

All cases of failure to pass the test are also to be reported to the Principal Examiner of Masters and Mates on Form Exn. 17 B.

### 2.—*Colour Vision Test.*

(1) *Nature of the test.*—The colour vision of candidates is to be tested by means of Holmgren's wools.

The wools are always to be kept in the tins provided for the purpose, except when in use at an examination, in order that they may not become faded or dirty. Each set contains about 135 skeins of wool.

(2) *General instructions.*—Before the examination commences the skeins should be separated from one another, but each separate skein should be kept tied up as when first received.

The five test skeins which must *always* be used at each examination, and in the order named, are labelled respectively I (light green), II (pink), III (red), IV (purple), and V (yellow).

Care must be taken that the labels do not get detached.

The colour vision test should be held only by daylight. If a good natural light is not obtainable the test must be postponed. When the weather is dark or foggy and a candidate cannot be examined in colours before his examination in navigation commences, he may be allowed to proceed with the examination in navigation provided he is examined in colours on the first available opportunity.*

(3) *Course to be followed if Incorrect Selections are made by Candidates.*—The examiner, as the examination proceeds, should carefully place on one side the skeins, the selection of which by the candidate seems to indicate a defect in colour vision, taking care to discriminate between those selected as matching each of the five test skeins.

The skeins, which have been correctly selected, should be returned to the general heap on the completion of each of the five tests.

(4) *Pieces of the Wools Incorrectly Selected by a Candidate who fails are to be sent to the Principal Examiner of Masters and Mates.*—In every case in which the examiner rejects a candidate, or is in doubt as to whether he should reject him or not, he is, when the examination is finished, to cut a small piece (say, an inch) off *every one of the actual skeins incorrectly selected by the candidate*, and to stitch the pieces cut off on to Form Exn. 17 C, keeping the pieces cut off the skeins selected as matches to the first test skein in one line, the pieces cut off the skeins selected as matches to the second test skein in a second line, and the pieces cut off the skeins selected as matches to the third test skein in a third line, and similarly for the fourth and fifth tests. The form (Exn. 17 C) with the pieces of wool attached to it is then to be forwarded to the Principal Examiner of Masters and Mates. with the examiner's report, on Form Exn. 17 B.

The greatest care must be taken that the pieces forwarded are cut off the actual skeins selected by the candidate, in order that there may be a reliable record of the actual selections made by the candidate if any question should subsequently arise.

Pieces need not be cut off the test skeins, but only off the skeins incorrectly selected by the candidate.

(5) The examiner should also note any incorrect skeins selected and withdrawn or seriously handled or compared with the test skein by the candidate, and should when this occurs submit the case with similar portions of the incorrect skeins and his remarks on Form Exn. 17 C, together with the Form Exn. 17 B, to the Principal Examiner for his decision as to whether the candidate should be passed or failed.

(6) In cases in which the candidate passes the test, pieces need not be cut off the skeins he has selected.

(7) *Candidates are not required to Name the Colours of the Wools.*—During the colour vision test the examiner should avoid naming the colours of any of the wools, and should explain to the candidate that he does not require them to be named to him.

In the test for colour ignorance the candidate has to name three colours.

(8) As soon as the skeins become discoloured, or unduly reduced in size (say by one-third), owing to pieces having been cut off, application should be made to the Board of Trade by the examiner for a new set.

(9) *Examiners are not required to decide from what form of Colour Blindness an Unsuccessful Candidate is suffering.*—In the remarks which follow reference is made to different kinds of colour blindness (red blindness and green blindness), but the examiner is not required to form any conclusion as to the kind of colour blindness from which the candidate suffers, and should not offer the candidate any opinion on this point.

All that is required is that the examiner shall conduct the examination according to the rules laid down, the nature of the candidate's colour blindness being immaterial.

(10) *Result of tests to be reported.*—The result of every test should be reported to the Registrar-General of Seamen on the Form Exn. 2, and to the Principal Examiner of Masters and Mates on the Form Exn. 14, when the candidate is up for examination for a certificate of competency; and to the Registrar-General of Seamen on the Form Exn. 2 A, when the candidate is up for examination in colours only.

All cases of failure should also be reported to the Principal Examiner of Masters and Mates on Form Exn. 17 B, to which should be attached Form Exn. 17 C, containing the pieces of the wools incorrectly selected by the candidate.

#### *Method of Testing for Colour.*

The method of testing consists in asking the candidate to select from variously coloured objects those which appear of the same colour as one which the examiner selects. The most suitable objects and at the same time the most readily obtainable are skeins of wool, which can be procured of almost every desired hue and tone. An advantage of skeins of wool, besides their portability, is that, owing to their want of gloss, they appear of approximately the same tone from whichever side they are viewed. The colours of the skeins to be selected include reds, oranges, yellows, yellowish-greens, pure greens, blue-greens, blues, violets, purples, pinks, browns, and greys. Several shades of each colour, with at least five graduations of each tint, are provided, from the deepest to the lightest greens and greys. Varieties of pinks, blues, and violets, and of light grey, together with shades of brown, yellow, red, and pink, are well represented. The test skeins with which the examinees are to

* When the examination in navigation precedes the colour tests the candidates should be informed that the examination in navigation will be cancelled if they should fail to pass the colour tests.



compare the other skeins are five in number:—(1) a light green; (2) a pink; (3) a bright red; (4) a purple; and (5) a yellow. These five colours will suffice to indicate approximately the amount and kind of colour blindness which may exist. The light green skein, which is a tolerably pure green mixed with a large proportion of white, is chosen as the colour which closely matches the spectrum colour which the red and green blind distinguish as white or grey. It is chosen of a pale tint, as it then becomes puzzling to the colour blind to distinguish its colour by luminosity. A light grey or drab skein will represent the same brightness to him that this pale colour does, and although he may be trained to distinguish bright colours by their relative luminosities, in the case of these pale varieties he will be unable to do so. The pink is chosen for similar reasons, and in fact it is nearly a complementary colour to the green. The pink is, according to the Young-Helmholtz theory, a mixture of two fundamental colours, the blue and the red, and as in the green blind it excites both the blue and red sensations it may be confused with grey, or with a green. In the red colour blind it excites in excess the blue sensations mixed with what they call white. A blue or violet may therefore be matched with it.

The method of examination is as follows:—

#### *Method of Examination and Diagnosis.*

The wools are placed in a heap on a large table covered by a white cloth or white paper, and in broad daylight. The first test skein is taken from the pile, and laid far enough away from the others not to be confounded with them during the examination. The person examined is requested to look carefully at the test skein and then to select other skeins from the pile most nearly resembling it in colour, and to place them by the side of the sample. At the outset, it is necessary that he should thoroughly understand that he is required to search the heap for the skeins which make an impression on his chromatic sense or sense of colour, similar to that made by the test skein, and quite independently of any name he may give the colour. The examiner should explain that resemblance in every respect is not necessary; that there are no two specimens exactly alike; that the only question is the resemblance of the *colour*; and that, consequently, the candidate must endeavour to find something similar in shade and something lighter and something darker of the same colour.

If the person examined cannot succeed in understanding this by a verbal explanation, *resort must be had to action.* The examiner should himself pick out the skeins, thereby showing in a practical manner what is meant by a shade, and then restore the whole to the pile, except the sample skein. *This should always be done before a candidate is reported as failed.*

As it would require too much time to examine every individual in this way, it is advisable, when examining large numbers, to instruct them all at once, and to ask them to attentively observe the examination of those preceding them so as to become more familiar themselves with the process. This saves time, and there is no loss of security, for no one with a defective chromatic sense will be able to find the correct skeins in the heap the more easily from having a moment before seen others looking for and arranging them. He will make the same characteristic mistakes; but the normal observer, on the other hand, will generally accomplish his task much better and more quickly after having seen how it has to be done.

The coloured plate shows the test colours, that is, those which the examiner presents to the persons examined.*

As to the similarity between the confusion colours and the wools which the colour blind take from the heap, reliance must be placed simply on the hue, and not their brightness or degree of colour saturation.

We can now pass directly to the test itself. The following are the directions for conducting it, and for making a diagnosis of the results:—

TEST I.—The *green* test skein which is labelled Test No. I. in the bundle is placed before the candidate.

* Not printed.

This sample is the palest shade (the lightest) of very pure green, which is neither a yellow-green nor a blue-green to the normal eye, but fairly intermediate between the two, or at least not verging upon yellowish-green.

*Rule.*—The examination must continue until the examinee has placed near the test skein all or nearly all the skeins of the same colour, or else, with these or separately, one or more incorrect skeins, or until he has sufficiently proved that he can easily and unerringly distinguish the correct colours, or else has given unmistakable proof of a difficulty in accomplishing it.

*Diagnosis.*—An examinee who places with the test skein "incorrect colours"—that is to say, who thinks that they resemble the "test colour"—is *colour blind*, whilst if he evinces a manifest disposition to do so, though he does not absolutely do so, he has a *feeble chromatic sense* or sense of colour.

TEST II.—The *pink* skein, which is labelled No. II., is placed before the candidate. The colour is midway between the lightest and darkest. It only approaches that given as II. of the Plate, as the colour of the wool is much more brilliant and saturated, and bluer.

*Rule.*—The trial must be continued until the examinee has placed all or the greater part of the skeins of the same colour near the test skein, or else, together or separately, several incorrect skeins. If he is colour blind he will probably select either the light or deep shades of blue and violet, especially the deep, or the light or deep shades of one kind of green or grey inclining to blue.

TEST III.—The *red* skein labelled No. III. is placed before the candidate. It is necessary to have a vivid red colour, like the red flag used as signals on railways. The colour should be that of III. of the Plate, rather towards yellowish-red.

*Rule.*—This test should be continued until the person examined has placed beside the test skein the greater part of the skeins belonging to this hue, or else several "incorrect skeins."

TEST IV.—The *purple* skein labelled No. IV. is placed before the candidate.

*Rule.*—This test should be continued until the person examined has placed beside the test skein all or nearly all of the skeins belonging to that colour, or else several incorrect skeins. If he is colour blind he will most probably select any shade of blue or green, also pinks and greys.

TEST V.—The *yellow* skein labelled No. V. is placed before the candidate.

*Rule.*—This test should be continued until the person examined has placed beside the test skein all or nearly all of the skeins belonging to that colour, or else several incorrect skeins. If he is colour blind he will most probably select greenish-yellows, light yellow-greens, fawns and pinks.

*Remark.*—Every case of comparatively complete colour blindness does not always give precisely the same mistakes. Instances occur of persons who are not completely colour blind, or of completely colour blind persons who have been practised in the colours of signals, and who endeavour not to be discovered. They usually confound at least green and brown, but even this does not always happen.

*Mono-chromatic Vision.*—The absence of every colour sensation except one will be recognised by the confusion of all the hues, which will appear to be of the same intensity of light or brightness.

#### *Special Instructions to Examiners.*

In the conduct of the Colour Test the sole question under consideration is whether or not the candidate has normal colour vision, and in order to answer this question satisfactorily no pains must be spared by the examiner to make the candidate fully understand what he is expected to do. As the result of the local examination often hinges upon the adequacy or otherwise of the instruction given to the candidate together with the intelligent interpretation of the Rules laid down for the guidance of the examiner, it is very important that examiners should be able to modify

their mode of procedure with different candidates in order to gain the best results from the varied types which come up for examination in these tests.

Before going into the question of how to treat different cases, examiners should always bear in mind that no amount of verbal explanation is equivalent to practical instruction, and as the test is in nowise vitiated by being seen be forehand, opportunity should be given, when possible, to prospective candidates to see others tested. Candidates undergoing the Colour Tests may be broadly divided into two classes irrespective of whether they are colour normal or not, viz. (*a*) those who make a rapid selection of a large number of skeins to the required test; and (*b*) those who are slow and hesitating.

In the majority of cases the simple request by the examiner for the candidate to "pick out from the "heap of wools all those skeins which are of the same "colour—both lighter and darker—as the test skein" will be found sufficient, but where a candidate shows a tendency to pick out a large number of skeins which even remotely resemble the test skein in colour as in (*a*) he should at once be stopped, and be given to understand that it is not desired that the original test colour should be graded off into another, *i.e.*, by his introduction of, say, yellow-green skeins into the first test he can easily be shown that a simple graduation of shade will speedily land him in yellow, or a very near approach to it. This can best be demonstrated by the examiner taking one of the shades of yellow-green verging on yellow and placing it beside the test skein at the same time asking the candidate if it is the same *colour*, when, if the candidate is colour normal he will very likely at once remark that it is too yellow. The candidate should then be told to return the whole of his selections to the heap, and, after reshuffling them, be made to commence afresh, when in all probability he will understand what is required and the test will be rapidly completed. The same remarks apply to cases where the blue-green range of skeins is introduced.

It will be seen that the introduction of these mixed green skeins need not be taken as a positive indication of defective colour vision, as the chances are that these selections are made through ignorance of what is required. Should, however, the candidate introduce amongst the selections any obviously incorrect skeins, *i.e.*, skeins in which there is no green, the examiner must proceed carefully, noting at the same time any tendency to handle incorrect skeins and to compare them with the test skein. In cases of this kind when there are other candidates up for examination it is best to postpone the trial until the candidate has had an opportunity of seeing what is done by others or, failing this, the examiner himself should pick out all the correct skeins to the test, showing the candidate what he is expected to do: If the candidate has defective colour vision the same characteristic mistakes will be made. The second case (*b*)—where a candidate is slow and hesitating—may be due to several causes, nervousness, anxiety as to result, real or fancied defective colour vision, &c. All candidates, the latter especially, must be tactfully dealt with, in order to get the best results from the examination. Candidates of this latter type often evince a tendency to obstruct their own work by gathering up handfuls of the skeins with one or both hands and turning them over without any result, at the same time bending over the wools in a more or less strained position. The examiner should then quietly tell the candidate to stand back a moment, and having spread out the skeins again tell him to put his hands by his side, look at the heap of wools, and when he thinks he sees a skein of the required colour, to pick it up and place it beside the test skein, at the same time showing him practically what he means him to do. This will tend to reassure him, and at the same time give him a chance of seeing the skeins required, and the test should be continued until all or nearly all the correct skeins have been picked out. Again, candidates will be found who show a tendency to compare skeins with the test skein, and if not exactly the same shade (though perhaps quite correct in colour) to reject them. This is very likely due to failure to understand the instructions given by the examiner, and the candidate should then be reminded that he will find no exact match, but that several shades of the same colour both lighter and darker are to be found in the heap. Should he, however, evince a tendency to compare obviously incorrect skeins with the test skein, careful note should be taken of the colours. Candidates of this type whose colour vision is defective, and who may be aware of the defect, will probably select few wools on the chance that what they pick out may be correct. It is accordingly essential that in all cases a fair number of skeins to each test should be required, as the colour-blind candidate may of course pick out correct skeins as well as incorrect ones, since all look more or less alike to him. The experienced examiner can usually recognise such cases by the tentative manner in which the various skeins are handled; and although the candidate may not actually compare incorrect skeins with the test skein, the fact that he has seriously handled them with a view to selection should be carefully noted.

When the candidate has successfully passed the first test, as a rule, the other tests will be passed easily; but the same care must be taken to see that the test colour, and that only, is selected, or if incorrect colours are seriously handled or compared with the test skein, a careful note of them must be taken as before.

In no case should an examiner pick up incorrectly selected skeins and ask the candidate "Do they match the test"? If the examiner is not satisfied that the candidate knows what he is expected to do, the whole of the wools should be returned to the heap and the test commenced anew, when, if the candidate is really defective in colour sense, the same characteristic mistakes will be made.

Examiners should bear in mind that these tests should always be conducted in a good light. The skeins of wool should be placed on a table covered with a white cloth or paper of sufficient size so that ample room is given for the candidate to search the heap and place his selections well clear of both the heap of wools and the test skein. It is also advisable that the table should be placed so that a strong sunlight should not fall directly on the wools and white table cover, as this has rather a dazzling effect upon the eyes.

In view of the extreme importance of the proper and efficient conduct of these colour tests, examiners should strictly adhere to the rules laid down, and on no account should candidates be passed who make incorrect selections though they may be subsequently withdrawn, or who seriously handle or compare incorrect skeins. All such cases should be submitted to the Principal Examiner for his decision.

### 3. *Colour Ignorance Test.*

(1) *Object of Test for Colour Ignorance.*—The object of this test is simply to ascertain whether the candidate knows the names of the three colours—red, green, and white—which it is important for every seaman to be acquainted with, and the test is to be confined to naming those colours.

(2) *Manner in which the Test is to be Conducted.*—One or two of the purest red and green skeins should be selected from the set of wools, and the candidate should be required to name their colours. He should also be required to name the colour of any white object, such as a piece of white paper.

(3) *Grounds on which Candidates should be treated as having Passed or Failed.*—If he answers correctly he should be considered to have passed the test. If he makes any mistake he should be failed.

(4) *Result of Tests to be Reported.*—The result of every test should be reported to the Registrar-General of Seamen on the Form Exn. 2, and to the Principal Examiner of Masters and Mates on the Form Exn. 14, when the candidate is up for examination for a certificate of competency; and to the Registrar-General of Seamen on the Form Exn. 2 A, when the candidate is up for examination in colours only.

All cases of failure should be reported to the Principal Examiner of Masters and Mates on Form Exn. 17 B.



## APPENDIX Oa.

The standard in form vision to be required of all candidates prior to January 1, 1914, except when they elect to take the higher standard, and thereafter in the case of candidates who already hold certificates of competency is as follows:—

If the candidate can read correctly *five of the eight letters in the fifth line* from the top of the sheet of letters he may be considered to have passed the test. If he cannot do so, his case should be submitted to the Principal Examiner of Masters and Mates.

Candidates may use both eyes or either eye when being tested for this standard, but the candidate should be tested with at least two sheets of letters, and the test should be conducted in other respects in accordance with the general instructions in Appendix O.

The colour vision and colour ignorance tests are the same for both standards.

*Note.*—The examiners should in all cases point out to boys and others coming up for the Sight Tests that unless they are in possession of a certificate of competency by the 1st January 1914, they will after that date be required to pass the new standard of Form Vision as laid down in Appendix O, whether they are coming up for a certificate of competency or for examination in the Sight Tests only.

## No. 7.

*(Handed in by Sir Walter J. Howell, K.C.B.)*

BOARD OF TRADE SIGHT TESTS, 1877–1909.

TABLE I.

SHOWING THE RESULTS OF THE OLD COLOUR-VISION TEST, 1877–1894.

| Year (June 1st to May 31st). | Candidates entering for a certificate of competency. | | | Candidates entering for the sight tests only. | | |
|---|---|---|---|---|---|---|
| | Number examined. | Number rejected. | Percentage rejected. | Number examined. | Number rejected. | Percentage rejected. |
| 1877–79 (Two years) - | 5,967 | 26 | ·43 | — | — | — |
| 1879–80 - - - - | 4,334 | 16 | ·37 | 10 | — | — |
| 1880–81 - - - - | 4,319 | 16 | ·37 | 182 | 5 | 2·75 |
| 1881–82 - - - - | 4,079 | 19 | ·46 | 59 | 8 | 13·56 |
| 1882–83 - - - - | 4,009 | 26 | ·65 | 69 | 6 | 8·7 |
| 1883–84 - - - - | 4,603 | 17 | ·37 | 56 | 10 | 17·86 |
| 1884–85 - - - - | 4,350 | 23 | ·52 | 110 | 8 | 7·27 |
| 1885–86 - - - - | 4,215 | 45 | 1·06 | 294 | 18 | 6·12 |
| 1886–87 - - - - | 4,124 | 25 | ·61 | 415 | 26 | 6·27 |
| 1887–88 - - - - | 4,128 | 17 | ·41 | 837 | 33 | 3·94 |
| 1888–89 - - - - | 4,443 | 18 | ·40 | 789 | 36 | 4·56 |
| 1889–90 - - - - | 4,662 | 23 | ·49 | 839 | 29 | 3·45 |
| 1890–91 - - - - | 4,688 | 31 | ·66 | 601 | 32 | 5·3 |
| 1891–92 - - - - | 4,652 | 27 | ·58 | 567 | 16 | 2·82 |
| 1892–93 - - - - | 4,577 | 35 | ·76 | 623 | 26 | 4·3 |
| †1893–94 - - - - | 5,744 | 45 | ·78 | 919 | 36 | 3·9 |
| Total - - | 72,894 | 409 | ·56 | 6,370 | 289 | 4·5 |

† Covering 15 months to 31st August 1894.

TABLE II.*

SHOWING the RESULTS of the NEW SIGHT TESTS, 1894–1909.

| YEAR. | Number of Examinations in Form-vision. | Number of Failures in Form-vision.† | Percentage of Failures in Form-vision. | Number of Candidates Examined in Colour-vision. | Number of Failures in the Local Colour-vision Test (wools). | Number of Appeals against Failure in the Local Test.‡ | Number of Successful Appeals (Spectroscopic Test). | Number of Unsuccessful Appeals. | Percentage of Successful Appeals. | Percentage finally Failed in Colour-vision. | Candidates failed in Colour-vision who had previously passed (a) the old test. | Candidates failed in Colour-vision who had previously passed (b) the new test. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1894 Sept. 1st to 1895 Dec. 31st. | 6,795 | 115 | 1·70 | 6,680 | 101 | 28 | 9 | 19 | 32·14 | 1·38 | 2 | — |
| 1896 - - - | 5,053 | 36 | ·71 | 5,017 | 56 | 12 | 5 | 7 | 41·67 | 1·02 | 2 | — |
| 1897 - - - | 5,979 | 36 | ·60 | 5,943 | 41 | 12 | 2 | 10 | 16·67 | ·66 | — | — |
| 1898 - - - | 4,104 | 24 | ·58 | 4,080 | 34 | 6 | 1 | 5 | 16·67 | ·81 | — | — |
| 1899 - - - | 4,642 | 21 | ·45 | 4,621 | 43 | 14 | 4 | 10 | 28·57 | ·87 | — | 2 |
| 1900§ - - - | 4,318 | 18 | ·42 | 4,300 | 36 | 12 | 5 | 7 | 41·67 | ·72 | — | 2 |
| 1901 - - - | 4,902 | 24 | ·49 | 4,878 | 50 | 15 | 5 | 10 | 33·34 | ·92 | — | 1 |
| 1902 - - - | 4,622 | 22 | ·48 | 4,600 | 35 | 7 | 1 | 6 | 14·29 | ·74 | 1 | 1 |
| 1903 - - - | 4,641 | 19 | ·41 | 4,622 | 21 | 8 | 0 | 8 | — | ·45 | — | 1 |
| 1904 - - - | 6,331 | 39 | ·62 | 6,292 | 71 | 23 | 12 | 11 | 52·17 | ·94 | 3 | 4 |
| 1905 - - - | 5,929 | 40 | ·67 | 5,889 | 55 | 21 | 8 | 13 | 38·10 | ·80 | 1 | 7 |
| 1906 - - - | 6,471 | 61 | ·94 | 6,410 | 57 | 15 | 9 | 6 | 60·00 | ·75 | — | 10 |
| 1907 - - - | 6,627 | 63 | ·95 | 6,564 | 76 | 21 | 4 | 17 | 19·05 | 1·10 | — | 7 |
| 1908 - - - | 6,365 | 77 | 1·21 | 6,288 | 51 | 15 | 7 | 8 | 46·67 | ·70 | 1 | 2 |
| 1909, Jan.–Oct. - Nov. & Dec. | 6,084 | 56 | ·92 | 5,146<br>882 | 65<br>21 | 20<br>11 | 10<br>5 | 10<br>6 | 50·00<br>45·45 | 1·07<br>1·81 | — | 10 |
| Total - - | 82,863 | 651 | ·78 | 82,212 | 813 | 240 | 87 | 153 | 36·25 | ·80 | 10 | 47 |

NOTE.—The above figures are no guide to the general incidence of defective form-vision or colour-blindness. Many persons are no doubt deterred by consciousness of a defect in their vision from entering for a certificate or for the sight tests. Further a candidate undergoes the tests whenever he enters for examination for a certificate; while he may be re-examined after failure in the form-vision tests as often as he wishes. Thus many persons appear more than once in the return.

* The figures differ slightly from those shown in the Annual Report upon the Sight Tests, which it has been found desirable to correct in a few places.

† Some of the candidates shown as failed passed at a subsequent examination.

‡ Examinations on appeal conducted in the year after that in which the candidate failed are counted in the total of the year in which he failed.

§ Since November 1900, fishermen entering for examination for certificates of competency have been obliged to undergo the new sight tests.

## No. 8.

*(Handed in by Sir Walter J. Howell, K.C.B.)*

MEMORANDUM on the CANCELLATION in the UNITED KINGDOM of a CERTIFICATE of COMPETENCY by reason of the DEFECTIVE VISION of its HOLDER.

*(The References in the following Note are to the Merchant Shipping Act, 1894.)*

1. The Board of Trade have no power to cancel a certificate of competency once granted, unless it is shown that the holder "has been convicted of any offence" (Section 469).

If, however, the Board have reason to believe that the holder of a certificate "is from incompetency . . " unfit to discharge his duties" they may under the provisions of Section 471 cause an Inquiry to be held.

Such Inquiry may be held either before—

(a) a "person" appointed by the Board who must hold the Inquiry with the assistance of a local stipendiary magistrate, or if there is no such magistrate available, of a competent legal assistant appointed by the Board.

(b) a local marine board similarly assisted, directed by the Board of Trade to hold the Inquiry, or

(c) where there is no local marine board before which the parties and witnesses can conveniently attend, or the local marine board is unwilling to hold the Inquiry, then before a court of summary jurisdiction directed by the Board of Trade to hold the Inquiry.

Under the provisions of Section 470 (1) (b) the certificate of a Master, Mate, or Engineer may be cancelled by any of the above-mentioned tribunals if they find that he is incompetent.

In practice the Board of Trade have referred cases involving the question of defective eyesight to local marine boards except in one instance, when they appointed a "person" to hold the Inquiry, with the assistance of a local stipendiary magistrate also appointed by them.

Under Section 475 certain powers and duties are conferred on the Board of Trade as follows:—

475.—(1) The Board of Trade may, in any case where, under this Part of this Act, a formal investigation as aforesaid into a shipping casualty, or an inquiry into the conduct of a master, mate, or engineer has been held, order the case to be re-heard either generally or as to any part thereof, and shall do so—

(a) if new and important evidence which could not be produced at the investigation or inquiry has been discovered; or

(b) if for any other reason there has in their opinion been ground for suspecting that a miscarriage of justice has occurred.

(2) The Board of Trade may order the case to be re-heard, either by the court or authority by whom the case was heard, in the first instance, or by the Wreck Commissioner, or in England or Ireland by the High Court, or in Scotland by the Senior Lord Ordinary, or any other judge in the Court of Session whom the Lord President of that court may appoint for the purpose, and the case shall be so re-heard accordingly.

(3) Where on any such investigation or inquiry a decision has been given with respect to the cancelling or suspension of the certificate of a master, mate, or engineer, and an application for a re-hearing under this section has not been made or has been refused, an appeal shall lie from the decision to the following courts, namely,—

(a) If the decision is given in England or by a naval court, to the High Court;

(b) If the decision is given in Scotland, to either division of the Court of Session;

(c) If the decision is given in Ireland, to the High Court in Ireland.

(4) Any re-hearing or appeal under this section shall be subject to and conducted in accordance with such conditions and regulations as may be prescribed by rules made in relation thereto under the powers contained in this Part of this Act.



## APPENDIX B.

STATEMENTS SHOWING NUMBER AND CAUSES OF COLLISIONS AND STRANDINGS.

The following statements, which show the number and causes of the collisions and strandings which have occurred in each of the years 1894 to 1908, have been compiled from the Board of Trade Wreck Abstracts. In order to show the increase which has taken place in the British mercantile marine and the extent to which it is employed, a table has been added showing for each year the net registered tonnage of United Kingdom vessels, the number of entrances and clearances in the United Kingdom, and the total British tonnage entered and cleared in the principal ports of the world.

TABLE I.

STATEMENT showing the NUMBER of COLLISIONS which occurred on or near the COASTS of the UNITED KINGDOM during the 14 years ended 30th June 1908, or were reported during the same period as having occurred to BRITISH VESSELS ABROAD, or to FOREIGN VESSELS on or near the COASTS of BRITISH POSSESSIONS ABROAD, and showing also, when known, the CAUSES to which the COLLISIONS were attributed.

| Year. | Parting Cables, Dragging Anchors, Breaking Sheer and Fouling. | Missing Buoys. | Anchoring in a Foul Berth. | Want of Sea Room or crowded Navigation. | Thick and Foggy Weather. | Bad Look-out. | Neglecting to show Lights. | Neglect or Misapprehension of Steering and Sailing Rules. | Error of Pilot. | Want of Seamanship. | General Negligence and want of Caution. | Inevitable Accident. | Error in Judgment. | Cause unknown. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1894–5 | 102 | 11 | 14 | 65 | 123 | 101 | 48 | 120 | 28 | 6 | 165 | 141 | 156 | 209 | 1,280 |
| 1895–6 | 52 | 5 | 13 | 50 | 105 | 96 | 52 | 118 | 29 | 4 | 143 | 126 | 136 | 173 | 1,102 |
| 1896–7 | 81 | 8 | 22 | 58 | 106 | 119 | 47 | 128 | 27 | 10 | 165 | 126 | 150 | 176 | 1,223 |
| 1897–8 | 66 | 11 | 20 | 59 | 103 | 101 | 55 | 123 | 34 | 9 | 144 | 146 | 153 | 184 | 1,208 |
| 1898–9 | 88 | 6 | 15 | 54 | 103 | 109 | 48 | 109 | 28 | 11 | 133 | 134 | 139 | 167 | 1,144 |
| 1899–1900 | 48 | 4 | 23 | 53 | 105 | 100 | 47 | 98 | 29 | 9 | 119 | 117 | 129 | 162 | 1,043 |
| 1900–1 | 87 | 7 | 10 | 38 | 94 | 73 | 38 | 90 | 34 | 4 | 110 | 115 | 128 | 180 | 1,008 |
| 1901–2 | 57 | 3 | 14 | 41 | 90 | 105 | 39 | 108 | 32 | 8 | 128 | 108 | 133 | 185 | 1,051 |
| 1902–3 | 61 | 6 | 20 | 34 | 70 | 103 | 32 | 85 | 35 | 10 | 133 | 93 | 133 | 183 | 998 |
| 1903–4 | 76 | 9 | 21 | 50 | 88 | 102 | 44 | 90 | 46 | 12 | 132 | 108 | 132 | 212 | 1,122 |
| 1904–5 | 58 | 4 | 16 | 49 | 94 | 84 | 44 | 84 | 41 | 7 | 126 | 88 | 130 | 189 | 1,014 |
| 1905–6 | 54 | 11 | 17 | 47 | 86 | 81 | 31 | 79 | 30 | 11 | 124 | 84 | 125 | 200 | 980 |
| 1906–7 | 71 | 7 | 18 | 53 | 108 | 117 | 27 | 68 | 38 | 11 | 137 | 96 | 150 | 165 | 1,066 |
| 1907–8 | 66 | 4 | 14 | 54 | 111 | 112 | 27 | 73 | 46 | 13 | 143 | 97 | 143 | 149 | 1,052 |
| Average - | 69 | 7 | 17 | 50 | 99 | 100 | 41 | 98 | 34 | 9 | 136 | 113 | 138 | 180 | 1,092 |

TABLE II.

STATEMENT showing the NUMBER of STRANDINGS everywhere of TRADING VESSELS Registered in the UNITED KINGDOM and BRITISH POSSESSIONS ABROAD during each of the Statistical Years 1894–5 to 1907–8, showing also the CAUSES to which the CASUALTIES were attributed.

| Year. | Causes connected with | | | | Miscellaneous causes, other than the foregoing. | Unknown Causes. | Total. |
|---|---|---|---|---|---|---|---|
| | Equipment or Stowage. | Navigation and Seamanship. | Machinery or Boilers. | State of the Weather, Sea, &c. | | | |
| 1894–5 | 31 | 603 | 12 | 738 | 352 | 57 | 1,793 |
| 1895–6 | 18 | 597 | 16 | 593 | 375 | 71 | 1,670 |
| 1896–7 | 23 | 553 | 7 | 698 | 413 | 70 | 1,764 |
| 1897–8 | 13 | 502 | 9 | 718 | 371 | 69 | 1,682 |
| 1898–9 | 23 | 489 | 8 | 693 | 415 | 78 | 1,706 |
| 1899–1900 | 15 | 376 | 8 | 581 | 336 | 78 | 1,394 |
| 1900–1 | 9 | 321 | 8 | 583 | 274 | 144 | 1,339 |
| 1901–2 | 18 | 351 | 4 | 575 | 274 | 121 | 1,343 |
| 1902–3 | 22 | 372 | 10 | 652 | 290 | 111 | 1,457 |
| 1903–4 | 19 | 401 | 3 | 661 | 351 | 124 | 1,559 |
| 1904–5 | 16 | 375 | 8 | 647 | 330 | 109 | 1,485 |
| 1905–6 | 20 | 369 | 8 | 589 | 310 | 103 | 1,399 |
| 1906–7 | 18 | 370 | 4 | 785 | 183 | 106 | 1,466 |
| 1907–8 | 20 | 333 | — | 788 | 236 | 130 | 1,507 |
| Average - | 19 | 429 | 8 | 664 | 322 | 98 | 1,540 |

TABLE III.

| Year. | Total Net Tonnage of Vessels registered under Part I. of the Merchant Shipping Act, 1894, belonging to the United Kingdom, including Jersey, Guernsey, and the Isle of Man. | Number of Entrances and Clearances of British Vessels in the United Kingdom to and from Foreign Countries and British Possessions. | Total British Tonnage Entered and Cleared in the Foreign Trade of the Principal Maritime Countries and British Colonies. |
|---|---|---|---|
| | Tons. | | Millions of Tons.* |
| 1895 | 8,988,450 | 74,817 | 183 |
| 1896 | 9,020,282 | 77,223 | 193 |
| 1897 | 8,953,171 | 78,326 | 203 |
| 1898 | 9,001,860 | 77,082 | 208 |
| 1899 | 9,164,342 | 76,903 | 213 |
| 1900 | 9,304,108 | 75,311 | 212 |
| 1901 | 9,608,420 | 71,550 | 216 |
| 1902 | 10,054,770 | 70,930 | 223 |
| 1903 | 10,268,604 | 70,802 | 237 |
| 1904 | 10,554,520 | 70,392 | 243 |
| 1905 | 10,735,582 | 72,119 | 254 |
| 1906 | 11,167,332 | 76,442 | 268 |
| 1907 | 11,485,099 | 78,700 | 285 |
| 1908 | 11,541,394 | 73,963 | 285 |
| Average | 9,989,138 | 74,611 | 230 |

* These figures are compiled from the statistics given in the tables showing the progress of merchant shipping. They are only approximate figures, in that the details are not available for all the years named.

## APPENDIX C.

MEMORANDUM PREPARED for the COMMITTEE by GEORGE J. BURCH, M.A., D.Sc. OXON; F.R.S.

### I.

My special knowledge of colour-blindness began with the discovery, a good many years ago, that by exposing my eye to direct sunlight in the focus of a burning-glass behind a screen of red glass, I could render myself for a time completely colour-blind to red, so that scarlet geraniums appeared black, red roses appeared blue, and I made the same mistakes in matching skeins as are made by the red-blind.

Further investigation showed that other colours produced analogous, but different, effects. Finding that a powerful spectroscope would be needed to complete the research, I waited until I was able to use one bequeathed to the University of Oxford by the Dowager Duchess of Marlborough.

With this instrument I found, briefly, that there are four parts of the spectrum—a red, a green, a blue, and a violet—each of which produces a special and different form of colour-blindness, lasting long enough to enable me to test myself with Holmgren's wools and make other experiments.

From 1895 onwards I began to examine the colour-sensations of other people, testing them with Holmgren's wools, and also by a spectroscopic method of my own, based on my discovery of artificial colour-blindness. I found myself always able to understand their mistakes in matching colours, by referring to my own sensations whilst temporarily colour-blind, and hence also to determine the kind of colour-blindness in a given case.

The sensations during artificial colour-blindness are very impressive and not easily forgotten—the sight of anyone trying to match colours that are in reality different recalls them very powerfully.

During red-blindness the world looks curiously sombre—all the brilliancy seems to have gone out of it. The general effect is depressing. "General Jacqueminot" roses, even during partial red-blindness, have the same dull purple tinge that is assumed by the moss rose while fading. Yellow objects look green, and the orange parts of them darker instead of brighter; but the yellow is not of a brighter green than the young green leaves, which have the colour of green paint. Blue flowers remain blue, but free of any red tinge, *e.g.*, Canterbury bells look bluer but more dull. Borage and alkanet and gentian scarcely alter, nor does the violet cineraria. The purple cineraria looks violet, but less brilliant.

During green-blindness the brilliancy of the landscape is unchanged, but everything looks dry and dusty. Most flowers retain their colour, but the foliage is grey. The effect is suggestive of a pencil drawing with tinted flowers. The part of the spectrum where green ought to be is of a pearl grey shading off into blue grey on one side and pale terra-cotta on the other. When the green-blindness subsides it is as if Naples yellow were added to the palette.

During blue- and violet-blindness the landscape appears to lack white. The grass and the trees are of that peculiarly brilliant green that one sees in the paintings of some of the Impressionists. To the eye *not* rendered colour-blind the scenery appears chalky by comparison.

### II.—Practical Testing for Colour-Blindness.

In practice we have to deal with two classes of persons—the friendly and the unfriendly. Most of the scientific testing can be made to come under the first head, but nearly the whole of the technical testing comes under the second.

#### 1.—THE FRIENDLY.

For those who sincerely desire to learn how their colour sensations compare with those of other people, I have no hesitation in saying that my spectroscopic method is the most certain, the quickest, and the best. I have tried it with white-haired working men and boys of 12 years old from elementary schools, and it succeeds with them as well as for the better educated. If I am led to suppose that a case is abnormal, I put out Holmgren's wools and ask to be shown, while getting the spectroscope ready, the colours about which a difficulty has been felt; but this is not necessary, though a knowledge of what to expect may shorten the process.

The routine of the method is described in Section XI. (*See also* Phil. Trans. 199 B., p. 231.)

A complete examination includes, of course, measurement of the colour-fields and separate determination of the sensations of the fovea. Of the methods I employ, it is sufficient for the present to say that they are all spectroscopic, and that for some purposes I use flashing light.

#### 2.—THE UNFRIENDLY.

The testing of those whose object is to pass the test, deceiving the examiner and concealing their deficiencies, is simply a battle of the wits. And though I have done it successfully with the spectroscope, not once but many times, I doubt if it would be worth the trouble, as it certainly would not be easy, if once the spectroscope were made familiar to the candidates.

It should be clearly understood that, while I hold that for scientific purposes no method of testing can compete with the spectroscopic method, I am equally convinced that it could not possibly be used for the purposes of the Board of Trade, except in dealing with an appeal, when I should most certainly employ it, among other tests.

I have never had any difficulty in diagnosing colour-blindness with Holmgren's wools, except from the indiscreet behaviour of bystanders, whose presence is as great a disadvantage as it would be to a card-player if they could see his hand.

My method of proceeding differs somewhat from that prescribed in the Board of Trade Regulations, and I prefer to have certain shades which I do not find in the official set of wools. The differences will be set forth in greater detail in Section V.

### III.—Technical Tests for Colour-Vision.

Holmgren's method was in practical use long before the time of Holmgren. It has been for generations part of the ordinary routine of the dye-works. When a dyer has a colour to match, he refers to his "pattern boxes," containing in many cases thousands of patterns, and searches among them for the colour most like that of the pattern given him. Having found one that is satisfactory, reference to his books tells him how it was done. Forty years ago a journeyman dyer would keep private notes of all the colours he had to dye, besides entering them in the "dye book" of the firm.

The foreman dyer takes the younger men and lets them practise matching patterns, those who fail to do it satisfactorily being kept to blacks, while those who have "a good eye for colour" are put on to that work. As a boy I have watched the men teaching and testing one another.

Some few years ago, after lecturing on Colour-Vision in the Examination Schools at Oxford, I saw one of the attendants—an old man since dead—handling the Holmgren wools. I said, "You have seen this kind of thing before." "Yes," he replied, "it is like old times. I used to dye the silk for ribbons at Coventry."

Now that, for dyers, is an ideal technical test, being a *sample of the work they have to do.*

For pilots and railway men it is not a good technical test. On the one hand it may reject men who fail to discriminate delicate shades of colour with which they have no concern, and on the other it may pass men who can distinguish coloured areas but confuse coloured points, such as distant signal lamps.

Moreover the conditions laid down by the Official Regulations are different from those which the seaman works under in the following respects:—

(*a*) *Photometrically.*—The test has to be conducted by bright daylight; that is to say, with a percentage of violet light greater than is given by any but arc light. This gives an advantage to a certain class of the green-blind who might not otherwise pass.

(*b*) *Physiologically.*—The prescribed conditions are those of complete light-adaptation, even to the point of putting the skeins on a white cloth—for many reasons a black cloth would be better—whereas the pilot is almost always under conditions of dark-adaptation, and has very often to pick out the coloured light from among the other lights of the same ship, either against darkness or against the background of an offing coloured by sunset or by moonlight. It would be difficult to arrange a test differing more from the conditions under which the man works than the official test.

I am strongly of opinion that the examination, as regards form-vision, colour-vision, and colour-ignorance tests should be truly technical, in the sense of being a sample of the work the man is expected to do, or as close an approximation to it as it is possible to make artificially.

The present system of testing assumes that—

1. No person who is colour-blind is fit to be a pilot.
2. No person who can pass Holmgren's test is colour-blind.

The opponents of the present system argue—

1. Some persons who are colour-blind are fit to be pilots.
2. Holmgren's test rejects some persons who are fit to be pilots.
3. Some persons not fit to be pilots have passed Holmgren's test.

My own view is—

(A) Some colour-blind persons are fit to be pilots IF, but ONLY IF, certain kinds of green glass are not used for signal lamps.

(B) Holmgren's test, as at present applied, does not with certainty discriminate between the dangerous and the harmless varieties of colour-blindness.

(C) The pellet test is open to the objection that it is absolutely useless against the man who has been coached for it. You need only tell him to look to one side of the pellets in matching the colours, instead of looking directly at them. Every now and then you find a man who does this habitually without realising that he is colour-blind for central vision.

## IV.—What Colour-Blind Persons should be rejected and what Coloured Glasses should be used.

In determining the best colours for signal lamps, we have to consider not only the men but the lights.

If all men could discriminate with certainty the four colours—red, green, blue, and violet—we could not use them, because it would reduce the intensity of the light too much—except in the case of red—to work with only one of its components.

Practically the problem reduces itself to that of finding at what part we can divide the spectrum so that the two halves shall be as nearly as possible equal in total luminosity and as unlike as possible in colour.

To the normal eye this division is in the yellow—the colours to the left sum up as red, and those to the right sum up as blue, if the source of illumination is the sun or the electric arc, and green, if it is a candle or an oil lamp.

To the red-blind the most striking change of colour is near the F-line where green passes into blue. He calls all colours to the left of this "yellow," and the sum of those to the right he calls blue.

To the green-blind the most striking change of colour is right in the middle of what we call green. All colours to the left of this give him the same impression that red does to us, though he often calls it "yellow," and all colours to the right of it sum up to him as "blue."

It is clear that to obtain two colours hat would look unlike to each of these three classes our "red" glass must stop everything to the right of *b* in the middle of the green. This would look dull yellow to the red-blind, and yellow to us. And our "blue" glass must stop everything to the left of F. This would produce a deep blue, of so little luminosity with ordinary lights as to be of no service. Moreover, the difference in colour between the yellow of our "red" light and the yellow of our "white" light would be so small as to make it difficult to judge except when both could be seen together.

It follows that unless we could always use arc light, so as to ensure plenty of violet to mark the difference between white and yellow, we could not provide a pair of signal colours that would be distinctive for the red-blind, the green-blind, and the normal.

We must therefore exclude the red-blind.

As to the green-blind and the normal—for these a compromise is possible. To divide the spectrum in the middle of the green (near the *b* lines) which gives the maximum *colour-contrast* between the two halves for the green-blind, does not divide it equally as regards brightness. To the green-blind the two colours are a blue almost identical with ultramarine, and a red the colour of dry vermilion powder, *i.e.*, not glazed or varnished. But the blue has much less luminosity than the red under ordinary conditions of light-adaptation, and for ordinary intensities such as those of signal lamps.

To the normal eye the sum-total of the light to the right of the *b* lines has more the colour of Prussian blue, and the sum-total of the light to the left has the hue of a solution of bichromate of potash, and is also very much more brilliant.

Now, although bichromate of potash offers a sufficient constrast to Prussian blue, it is not everyone who can *remember the difference* between it and the naked flame of a candle, without seeing the two within a few seconds of each other. To place the dividing line simply in the middle of the green would be, therefore, to sacrifice the normal-sighted to the green-blind, making it difficult for the normal to distinguish "red" (which would then be orange-yellow) from white.

But by sacrificing some portion of the spectrum, and using a red that transmits very little to the right of the sodium lines and a blue that cuts off practically all to the left of the *b* lines, we get a red which is "red," both to the normal and to the green-blind, and a blue also distinct to both of them.

The part of the spectrum which must be sacrificed is from orange-yellow to the middle of the green.

The danger rests with the green glass. There is a certain green, coloured I believe with oxide of iron, which has a leaf-green tint, especially if not very dark. One of the Oxford tramcars used to carry a lamp of this colour. I know from experience that it is most difficult after working on green light with the spectroscope to tell the colour of this lamp 300 yards away. If the light is burning brightly it looks white, if dimly it might easily be mistaken for red.

If there is any probability that such glass may be used on signal lamps, then I say without hesitation that no green-blind man ought to be passed, either as engine-driver or pilot, or in any capacity where he has to distinguish between red, green, and white signals.

It cannot be too clearly understood that a green-blind man makes no mistakes as between red and white or red and blue, but may even be more than ordinarily sensitive to a red tinge in a white light. A green-blind man confuses greens with pink or lilac, and the danger with him lies in the mistakes he will make with the *green* signal-glass. The colours on which he depends for his contrast are blue and violet. If these are lacking from the light, the green glass will appear very pale and of a neutral colour to him. If, in addition, it transmits the yellow-green, the light may even give him an impression of red.

If it should be decided to allow green-blind men to pass, I think they should be made clearly to understand that they *are* green-blind, and due record made of the fact. Under normal conditions, with good lights and good green glass, they are quite safe, but not, I think, with poor lights and iron-oxide glass.

It has seemed possible in certain cases to which my attention has been directed, that people have been rejected as red-blind who were in reality green-blind. In the absence of a complete knowledge of the data, I merely point out that such a result would be unfortunate, because, though the rejection was justified, the man's friends, finding him quite capable of recognising red lights, jump to the conclusion that he ought to have passed. The idea, originating with Hering, that red and green-blindness are necessarily connected, is largely responsible for this. Great emphasis should be laid on the fact that a man must be able to distinguish *green* from *white*, and *green from red, as well as red from white.*

A truly technical test, being independent of theory, would get over this difficulty.

The fact remains that a man may possess a well-developed red sensation and be absolutely green-blind,



or may have a strong green sensation while entirely deficient in red.

## V.—The Holmgren Wools Test.

My method of using Holmgren's wools differs in several ways from that described in the Regulations.

1. I never lay the skeins on a white cloth, but on some dark surface, preferably black.

2. I usually begin by asking the person tested to match the red skein, choosing for the purpose a red as free from yellow, green, and blue as possible—in fact the nearest approach to a pure spectral red, but at the same time a brilliant colour.

To the red-blind this has the colour of a dark-green ivy-leaf. I then watch the action of the hand in picking up skeins to match it. If dark greens and browns are gathered with it, there is more or less red-blindness. If orange and bright greens are picked up, green-blindness is more probable. At a later stage I pick up an ivy-green and ask for it to be matched. The red-blind pick up brilliant reds with this, quite unconscious of their brilliancy.

But I never allow witnesses to be present except at my demonstration classes. I do not always use the same red, but for each red there is a colour which to the red-blind matches it. Thus for "geranium" there is a dark blue-grey, and for yellow-ochre a brilliant green.

Similarly there is a set of colours that match to the green-blind, the most important being a greenish-blue and pink. But these immediately and instinctively reject the bright reds from among darker reds or browns.

It is important to know that I *always* have *one true match*, and sometimes several, to each colour.

One can then say "Go on and find more that match," or, "Find the next-best match."

When a number have been chosen I say "Arrange these in the order of their nearness to the sample colour."

This generally decides between cases of partial colour-blindness, red or green.

For the red-blind confuses reds and greens, matching scarlet with dark green or brown.

The green-blind confuses reds and greens but distinguishes scarlet from brown, matching it rather with bright yellow-green. And a series of browns and greens will be arranged by the partially red-blind in the order of their green components and by the partially green-blind in the order of their red components.

The green-blind confuses lilac with blue-green, the red-blind confuses it with magenta.

Partial blue or violet-blindness is the most common defect of all, but passes unnoticed and does not seem to be a drawback except to dyers. To detect it I use skeins dyed to a deep colour with aniline violet. These are confused by the violet-blind with black or dark red or brown. The "purple" test skein of the Regulations is far too pale a colour for this purpose.

I have found illiterate men afraid to try matching such delicate tints as the "pink" and "green" test skeins, but ready to attack with perfect confidence the full-toned greens, bronzes, and browns; and yet these are as certain to detect their colour-blindness as the confusion tints, if properly selected.

I take the pale "confusion colours" last.

I have as a rule *detected* the colour-blindness before reaching this stage, and it is easier to determine the character of it with less complex colours.

The "yellow test skein" is a colour of so little use that I never trouble to take it with me. The browns, dark greens, and slates give the information much more easily.

## VI.—Suggested Tests of Sight.

1. *Form-Vision*:—

Daylight. A test or measurement of visual acuity.

Night. To recognise the arrangement of groups of light at great distances.

Day. To recognise *shapes* of signals, *e.g.*, square, round, triangular, at great distances.

2. *Colour Knowledge.*—To recognise and name with certainty the colours used in signal, national, and house flags, both fresh and faded by exposure.

3. *Colour-Vision.*—To recognise the colour of signal lamps at great distances, and singly or amongst other lights, the colours used being in some cases full-toned good signal colours, and in other cases pale poor-coloured glasses, *e.g.*, green coloured by iron oxide, &c.

N.B.—"Great distances" would be simulated by optical means, to be described later. (Section IX.)

4. *Colour-Vision.*—For purposes of diagnosis Holmgren's test should be applied.

5. No. 3 would render the pellet test superfluous, and No. 2 would supersede the Colour Ignorance Test.

## VII.—Form-Vision Test.

The official test for form-vision is open to the objection that candidates may conceivably learn beforehand the order of the letters. This may be prevented in so simple a manner that I am surprised to find the precaution is not taken.

A man who has learnt off all the cards by heart recognises which is which by the large-type lines at the top. These, by the regulations, he is supposed to read first.

But if the eight cards were each cut up into separate lines containing letters of one size only, he would have no clue until he had *bonâ fide* read at least half the letters of a line.

And if the lines were exposed behind a screen which allowed only half the length of a line to be seen at one time the difficulty of cheating would be still further increased.

The cards might be labelled in *small type* A, B ... H, and the lines. representing size of type, numbered 1, 2, 3 .. to identify them to the *examiner* but not to the *candidate.*

As this test, though good, is not technical from the seaman's standpoint, it may be worth while to mention a method devised by myself about a year ago which *measures* the visual acuity instead of referring it to an arbitrary standard.

The candidate looks at a fine wire stretched in front of a sheet of white paper. He determines the greatest distance at which he can distinguish it. To prevent cheating, the frame carrying the wire can be rotated, and the candidate has to say what is the direction of the wire, and, in fact, to place a wire he carries parallel to it.

He then withdraws to a distance 1½ times as great and is shown two parallel wires. Being of the same diameter as the single wire, they are quite invisible to him until by means of a screw adjustment they are brought within a certain distance of each other, when they suddenly appear, not as two wires, but as one.

This may happen when they are from 3 to 5 millimetres apart, the wires being one-tenth of a millimetre in diameter.

From these data the visual acuity can be calculated. The phenomena require mathematics for their explanation, but depend upon a principle well known to opticians.

The method was tested this summer by a number of people and found to work well. Astigmatism is detected by it.

By substituting coloured screens for white, the colour-sensations of the fovea may be studied.

So far as the experiments have gone it appears to be free from the objections to the "pellet" test—if the candidate looks to one side he stands no chance of seeing the wire.

But in this respect a larger number of observations must be made. I propose asking the staff of the Oxford Eye Hospital to collaborate with me for the purpose.

## VIII.—Colour-Vision Test.

Edridge-Green's Lamp is the best apparatus on the market that I have seen, but I do not think it perfectly adapted for the purpose.

In it the source of light is a white porcelain surface illuminated by a small electric glow-lamp. It is viewed

through a series of circular apertures of different sizes whereof the smallest at 20 feet distance subtends the same angle as a signal lamp at 800 yards.

This does not precisely reproduce the conditions of actual work and therefore does not satisfy the conditions of a perfect technical test.

The *intrinsic luminosity* is *too low*. It is quite a different thing to look at a *very brilliant point* subtending a very small angle. And the angle subtended by a distant ship's light is a good deal less than that provided for.

Although Edridge-Green's lamp would serve far better than the pellet test to detect abnormal conditions of the fovea in the case of a friendly patient, it would be quite useless against a man bent on evading detection.

For detecting ordinary colour-blindness it answers extremely well.

## IX.—G. J. Burch's Proposed Test for Colour-Vision.

The following arrangement of apparatus was designed by me in January 1910, after reading the correspondence in the Press relating to Mr. Trattles, and was intended to meet cases such as his.

During May and June I set up the arrangement as to its essential parts and ascertained that it works extremely well.

Owing, unfortunately, to my long-continued illness I have not been able as yet to make a working model. It consists of two parts.

1. *The Ship's Lights.*—These are represented by apertures in a metal plate, behind which lamps (petroleum) are placed, coloured glasses being interposed as required.

An image of these illuminated apertures is formed in a definite plane by a camera lens, this image being large or small according to the distance of the apertures from the lens.

In the path of the rays, between the apertures and the camera, is an inverted telescope. If this is close to the camera, to a person looking at the image of the lights as seen from behind the camera they appear very small and distant. As the telescope is moved farther away the lights seem to grow bigger and approach, until at last they look quite large and near. But the special advantage of the arrangement is that the lights are sharply focussed all the time and their apparent distance is measured by the position of the telescope.

I have applied this method also to the apparatus described in Section VII. for measuring Visual Acuity. It answers well.

This part of the apparatus can be used to test both colour and form-vision quite independently of the part next described.

2. *The Scenery.*—To supply the background, with varying contrasts of sunset sky, moonlight, &c., I make use of the principle of Pepper's Ghost.

A picture of a distant coast or of the sea is fixed out of sight to one side, and the image of it projected by a diagonal mirror of plane unsilvered glass on to the above mentioned image of the lights, the distances being adjusted so that the image of the offing coincides with that of the lights when the telescope is close to the camera.

The effect, even with a very rough arrangement, is wonderfully realistic.

At first nothing can be seen. Then as the telescope is slowly moved away the light appears in the far distance, getting brighter and brighter until the separate lights can be distinguished, and finally it seems close at hand.

It is easy to mark the point at which the colour of the light can be seen—also to note the effect of the different backgrounds.

By viewing the whole through a convex lens of suitable power, so as to throw the common focal plane back to infinity, the apparatus can be kept within comparatively small compass.

Several lights can be made to appear, in different parts of the picture, and each can be made to approach or recede independently of the others.

The effect of a fog or mist is imitated by interposing between the diaphragm and the telescope a special kind of ground glass. The farther this is from the aperture, the greater the effect of fog.

The lights can be made to travel along the horizon, some in one direction and some in the other if desired.

But the test can be applied as efficaciously without any of these scenic effects. It may be as well to recapitulate what are the serious essential parts of the method:—

1. The use of direct light from the flame of a lamp so that the intrinsic luminosity shall be the same as that of the ship's lights.
2. The use of red and green glass of good, bad, and indifferent quality similar to what may be found on ships.
3. The production by optical means of a reduced image of the lights used, the size of which can be increased during observation by the device of an inverted telescope or other suitable system of movable lenses, the final image being at infinity or nearly so.
4. The superposition upon the image of the lights of a glare to represent sunset glow or moonlight, &c., this being done by a diagonal unsilvered mirror reflecting light from a patch of coloured paper, &c.. or, if preferred, from a picture of the sea.
5. An iris diaphragm or other variable aperture will serve to vary the apparent size of the light where only a single light is required.
6. The representation of fog by dulled glass *between* the *aperture* and the *eye*.

## X.—G. J. Burch's Theory of Colour Sensations.

To avoid confusion, it may be well to state briefly my own position with regard to the theory of colour sensations.

I hold the view of Thomas Young in its original form, viz., that we possess *four* separate and independent colour sensations, namely, *red*, *green*, *blue*, and *violet*.

The simultaneous and equal excitation of all these sensations produces in us the same effect as *white light*. [See Phil. Trans. 191 B. pp. 1–32, with the *Coloured Plates*.]

This differs from Helmholtz and the later form of Young's theory, according to which green plus violet equals blue, and therefore blue is not regarded as a separate sensation.

It differs from James Clarke Maxwell and others, who said that violet equals blue plus red, and did not consider violet as a separate sensation.

It differs from those who hold that white is a separate sensation.

It differs fundamentally and entirely from Hering's theory.

Thus in *nearly all* respects I may be regarded as upholding the Young-Helmholtz theory.

I do not agree with Edridge-Green's more complex theory. The phenomena he refers to are explicable much more simply. They occur wherever two colour sensations overlap. They are much affected by physiological and pathological conditions.

## XI.—Burch's Spectroscopic Method of Testing Colour Sensations.

My spectroscopic method of testing colour sensations depends on the fact that coloured light of quite moderate intensity rapidly induces a very noticeable degree of temporary colour-blindness if it occupies the entire visual field. This may be experienced by holding the eye near a large piece of scarlet cloth lying in the sun.

I therefore employ a spectroscope of considerable power, so that not more than one tenth part of the spectrum is visible at one time. The eyepiece must be one having a wide field of view, and the spectrum, instead of occupying a narrow ribbon in the middle of the field, must fill it from top to bottom as well as from side to side. A good bold pointer in the centre of the field serves as a reference mark.



### The First Stage.

The first step is to ascertain what names the candidate employs to describe the colour of the spectrum in various parts. It does not in the least matter whether these are right or wrong, all that the operator wants to know being at which points, according to the candidate, rapid changes of colour occur.

A person of normal vision describes them somewhat as follows:—Beginning at about 7600 on the left hand, the first is deep red, increasing rapidly to red, which remains constant for some distance. At a certain point it becomes scarlet, changing rapidly to orange, and then passing with great rapidity through yellow to yellow-green, and more gradually to green, which continues unchanged over another considerable portion of the spectrum. Quite suddenly this shows a trace of blue, and then passes through blue-green to blue with even greater rapidity than the change from red to green. Blue remains constant in hue for some distance, and then passes through indigo to violet, which ends about 3900.

If we could be quite sure that the names given by the candidate to these colours meant the same to him that they do to us, no further test would be needed. From his description of the colours of the spectrum we could deduce his colour sensation.

But they do not. What the red-blind calls red is to us dark ivy-green, what he calls yellow is our green. The green-blind often describe the green of the spectrum as green, though that colour has no existence for them.

### The Second Stage.

The second part of the test determines whether the change seen by the candidate is really a change of colour to him, or merely a change of brightness.

Suppose, for example, a man selects as the "best yellow," *i.e.*, neither inclining to orange nor to green, the D-lines of wave-length 5893, the colour given by a spirit lamp with salted wick. Telling him to fix the colour in his mind so as to be able to recognise it, I make him look for 30 seconds steadily at a part of the same spectrum where he can see no colour but red. Now, according to the theory of Young and Helmholtz, yellow results when the red sensation and the green sensation are equally excited. But during that short period the intensity of his sensation of red has been reduced to one-half, or even one-fifth of its original value, so that the sodium lines when he sees them again, instead of exciting 50 per cent. red and 50 per cent. green, give 30 per cent. red and 60 per cent. green, or even 16 per cent. red and 84 per cent. green, and therefore appear bright green. Hence the part of the spectrum that now looks pure yellow must have moved nearer to the red.

If, however, what he calls red is not really red to him but only the weaker part of his green sensation. and what he calls yellow is where that green begins to get stronger, then the effect of fatigue will be to necessitate his going farther into the green to reach a part bright enough for him to consider it yellow.

If, therefore, fatigue with red brings the "best yellow" of the spectrum nearer the red, then the man possesses a red sensation.

But if fatigue with red drives the "best yellow" farther into the green, then what he calls "red" is only the beginning of the green, and he has no red sensation.

After looking for 30 seconds at the green these same orange lines of sodium appear bright scarlet. Green, blue, and violet produce similar effects in other colours.

This being the principle, the following considerations have to be kept in mind in arranging the details of the test:—

1. Any sensation that has been fatigued must be given time to recover before being itself tested. This is done by working straight through the spectrum and back again.
2. The same degree of fatigue must be used for each observation. Thirty seconds is a convenient time, but a minute may be allowed if the light is poor.
3. The choice of colour must be made quickly before the effect of the temporary colour-blindness has subsided. The candidate is required to begin traversing the spectrum at the word "thirty," and to stop directly the right colour reaches the pointer, *without turning back*. Most people, after a couple of trials, manage this easily enough.

The following example shows how the observations are recorded. The figures are wave-lengths:—

*1st Stage. Normal Colour-boundaries.*

"Best yellow," *i.e.*, green meets red = 5785.
blue „ green = 4907.
"Indigo," *i.e.*, blue „ violet = 4650.

*2nd Stage. Fatigue Experiments.*

After looking at—
Red for 30 seconds green begins at 6010.
Green „ „ blue „ 5080.
Blue „ „ violet „ 4740.
Violet ends = 3900.

After looking at—
Violet for 30 seconds blue begins at 4555.
Blue „ „ green „ 4720.
Green „ „ red „ 5550.
Red ends = 7600.

From these data we find—

1. The extent of the colour sensations.—Red extends from 7600, where red ends, to 5550, where red appears after green; green extends from 6010, where green appears after red, to 4720, where green appears after blue; blue extends from 5080, where blue appears after green, to 4555, where blue appears after violet; violet extends from 4740, where violet appears after blue, to 3900, where violet ends.
2. The extent of the compound colours.—Yellow, where green overlaps red, from 6010 to 5550; blue-green, where blue overlaps green, from 5010 to 4720; indigo, where violet overlaps blue, from 4720 to 4555.

   Observe, moreover, that in this case, which is that of an artist, violet and green overlap in the middle of the blue from 4740 to 4720.
3. The middles of the overlaps correspond very closely with the "normal colour-boundaries" of the same person.

Thus red-green = 5780 instead of 5785; green-blue = 4900 instead of 4907; blue violet = 4648 instead of 4650.

Red-blind people have the spectrum shortened at the red end, no *true* change of colour near the yellow, but a change from green to blue, and one from blue to violet.

In green-blind people the red end of the spectrum is not shortened. They find no change of colour in the yellow nor in the blue-green, but a very sudden and striking change in the middle of what we call green, at about 5180, where to us there is no change. What we call blue-green they call indifferently "pink," or "green," or "grey."

The blue-blind are also uncertain in their names for the blue-green part of the spectrum. They find no change in the indigo near G, but their spectrum is not shortened in the violet.

The violet-blind have the spectrum shortened in the violet, and see no change of colour near G in the indigo.

If a colour sensation is found to occupy a much smaller extent of the spectrum than usual, the person is to be considered partially colour-blind in that respect. But time must always be given, and a second measurement taken to determine if the apparent colour-blindness is temporary.

A cricket match in the hot sun will make some people nearly green-blind for several hours.

# APPENDIX D.

## Memorandum supplied to the Committee by Dr. W. H. R. Rivers, F.R.S., Fellow of St. John's College, Cambridge.

I do not attempt to give in this report a full account of defects of colour-vision from the practical point of view, but merely to deal with certain aspects which seem to me especially important in relation to one of the problems referred to the Committee, viz., the determination of the degree of colour-blindness, in persons holding responsible positions at sea, which causes them to be incompetent to discharge their duties.

The most difficult problem which lies before the Committee concerns the capacity of persons suffering from the defect of colour-vision, first discovered by Lord Rayleigh, usually known in this country as "Individual variation of the colour sense" and in Germany as "Anomalous trichromatic vision." Our knowledge of this condition has advanced very greatly during the last few years, especially through the work of Guttmann.* It can now be regarded as established that persons who are anomalous in the match R + G = Y also suffer from definite weakness of vision for red and green, tending to confuse these colours when they are of low luminosity or saturation or when seen at a small visual angle. Further, Guttmann has shown that there is considerable delay in the recognition of these colours, a fact which becomes of importance in connection with the greatly increased speed of ocean travel and will certainly become increasingly important in the future. It is further clear that there are two distinct varieties of this condition, as originally pointed out by Lord Rayleigh; in one variety it seems that vision for red is especially weakened, while in the other it is the vision for green which is especially affected.

Since persons with this defect undoubtedly suffer from weakness of colour vision, I propose in what follows to speak of them as cases of colour-weakness. Nagel† has shown recently that so-called colour-blindness is not an absolute defect, and it is probable that there is no hard and fast line between so-called colour-blindness and colour-weakness.‡

Both Guttmann and Nagel§ are of the opinion that persons with this form of colour-weakness are sources of danger at sea and on railways, and Guttmann, who himself suffers from the defect, has made observations on himself from this point of view.

Guttmann‖ has tested large masses of persons in order to discover the frequency of the condition, and has found it in 5·1 per cent. of males in addition to the usual four per cent. of colour-blindness, and there is much reason to believe that the condition occurs with equal frequency in this country. It is notorious that these cases of colour-weakness pass Holmgren's test, usually with ease, and if the views of Nagel and Guttmann are accepted, the Committee will therefore have to consider the question whether large numbers of persons now holding responsible posts at sea, persons who have done so with perfect safety for many years, shall be disqualified by their defect.

It seems clear that this condition is one which exists in many degrees, but even if only the more gravely affected are to be rejected it will be a very serious matter. If, on the other hand, it be once conceded that the slighter degrees of the defect shall not disqualify, the Committee will be faced by a task of the utmost difficulty in determining where to draw the line at a point which will ensure reasonable, not to speak of absolute, safety.

The problem seems to me so serious and so difficult that before reaching any decision it is in my opinion incumbent on the Committee to take every possible means of arriving at some alternative measure or measures.

The present state of affairs is that there are many persons, perhaps hundreds, holding responsible positions at sea who suffer from weakness of vision for red and green, the colours used as signals, while few will doubt that there are many persons holding such positions who are definitely colour-blind, probably in our own marine, certainly in those of some other nations. It is universally acknowledged that even colour-blind persons are able to recognise the three lights used at sea, probably with ease and certainty under ordinary conditions, and in my opinion the first need at the present time is an inquiry into the means by which this recognition is effected, while a second equally important need is the study of the exact conditions which have to be met at sea. In my opinion no conclusions of any permanent value can be reached till such investigations have been carried out.

Very few exact observations have been made on the capacity of colour-defective persons to recognise coloured signals. In addition to those of Guttmann which I have already mentioned, an inquiry has been carried out by Nagel,* but it seems to me probable that this investigation was vitiated by the neglect of certain technical points to which I shall return later (*see* p. 4).

Though in my opinion definite conclusions can only be reached on the basis of actual experiments and observation, I propose now to consider what is to be expected from our present knowledge and to point out some of the conditions which must be taken into account in any investigation of the subject.

In approaching the study of these problems, the first point to be borne in mind is that the way in which a colour-blind or colour-weak person reacts towards colour does not depend merely on the nature of his sensory defect. It is well known that a person, who can be shown to be definitely colour-blind, will yet for practical purposes attain considerable success in the ordinary business of naming colours. The colour-blind person is able to distinguish by other criteria coloured objects which he is unable to distinguish by difference of hue. How far he is able to make use of these criteria depends on his general intelligence, and on the amount of attention he has devoted to colour. Two persons, who have precisely the same sensory defect, who can be shown by specially devised experimental procedure to be precisely alike, so far as mere sensory defect is concerned, may yet behave very differently in the recognition of colour. One may succeed in passing imperfect tests, while the other fails; and one may succeed in the practical act of distinguishing red and green lights for his whole life, while another may come to grief at the first real difficulty, It is this complexity of colour-blindness which makes its practical side so difficult; and it is the failure to recognise this complexity which is responsible for the character of much of so-called scientific work on colour-blindness.

In order to understand how colour-blind persons recognise coloured lights, it is necessary to discover what are the criteria upon which the colour-blind depend. There is no doubt that these are of three kinds—differences of hue, of luminosity, and of saturation. A red and a green light, which are wholly

* Zeitsch. f. Psych. u. Physiol. d. Sinnesorgane, Abt. II., 1908, Vol. 42, pp. 24 and 250; 1909, Vol. 43, pp. 146, 199, and 255. *See also* Levy, Ueber einem zweiten Typus des anomalen trichromatischen Farbensystems, Dissert. Freiburg, 1903.

† Zeitsch. f. Psych. u. Physiol. d. Sinnes., II. Abt., 1907, Vol. 41, p. 319, and 1910, Vol. 44, p. 5.

‡ Fresh evidence in favour of the unity of colour-blindness and colour-weakness has been published by Guttmann since the above was written. *See* Zeitsch. f. Psych. u. Physiol. d. Sinn., I. Abt., 1910, Vol. 57, p. 271.

§ *Ibid.*, Vol. 41, p. 239. *See also* Feilchenfeld, Arch. f. Augenheilkunde, 1904, Vol. 50, p. 48.

‖ *Op. cit.*, Vol 43, p. 217.

* Zeitsch. f. Psych. u. Physiol. d. Sinn., Abt. II., 1907, Vol. 41, p. 455.



different to the normal eye, may also be wholly different, on account of their difference in luminosity and saturation, to a person who confuses red and green, and of these saturation is especially important. Taking the lights used at sea as examples, the white light is generally yellowish, and the red light also yellowish, and therefore these two lights will appear in the same hue to the red-green blind person, but they differ wholly in saturation. While the colour in which the red light appears has a very high degree of saturation, the white light will obviously have a very low degree of saturation, and it is probably as a result of this difference of saturation that a colour-blind person never confuses these two lights. The red light, owing to its saturation, has a special quality which enables it to be recognised at once.

The recognition of the green light is a more difficult matter for the colour-blind, partly on account of the greater variability in the hue of the green lights used at sea. If the green is yellowish, it will for the red-green blind resemble other yellowish lights in hue. A certain green may be confused with a colourless light, while, if the green is decidedly bluish, it will be confused with other bluish lights but not with yellow lights. If the green light used is distinctly bluish, we have every reason to believe that the red-green blind person will never confuse it, either with a so-called white but really yellowish light, or with a yellowish-red light. The red and green light will also in this case differ as fundamentally to the colour-blind as to the normal eye. In consequence a blue-green light will never be confused with the red or white lights used at sea. If I am right—and I must point out again that I am only stating positively a position, which needs experimental investigation before it should be accepted—the criterion by means of which a red-green blind person distinguishes between the red and white lights used at sea is saturation, while the criterion in the distinction of a blue-green light from red and white lights is difference of hue. If the green light is yellowish, the criterion by means of which it is distinguished from red will again be saturation, but the only means by which such a green light is distinguished from a white light will be the very dangerous criterion of luminosity.

It is, I believe, generally recognised that criteria such as those I have been considering do, as a matter of fact, enable the colour-blind to distinguish the coloured lights used at sea, even with ease and certainty, under ordinary conditions. It is only under exceptional conditions that mistakes are liable to occur. One of the most important of these conditions is fog, and it may therefore be well to consider what might be expected to be the effects of fog, if the criteria are as I have supposed. One effect of fog will be to alter the apparent saturation of coloured lights; a coloured light seen through a foggy medium must have its apparent saturation affected; but whether fog is ever sufficient to do away with the difference of saturation between red and white lights, as seen by the red-green blind, is a matter which can only be settled by special investigation. Another effect of fog is to disperse and reflect blue light more than that of other wave-lengths, and thus to diminish the blueness of a bluish light. Here again the question, whether this effect can be great enough to do away with the difference in hue between blue-green and a red or white light, can only be settled by special investigation.

Another property of colour-blind vision is one of supreme practical importance. Colour-blind persons through their whole lives distinguish by means of certain criteria colours which to the normal eye differ in hue. In consequence, their power of discrimination in relation to these criteria is continually exercised, and, as a result of this exercise, it is found that the colour-blind can distinguish differences of luminosity and saturation more delicately than the person with normal colour-vision; and this increase may be so considerable that colour-blind persons may actually be able to see colours which are so faint as to be totally invisible to the normal eye.

The importance of this is obvious. A colour-blind person, who has found his way into a responsible position at sea, will be continually practising his capacity for the discrimination of the coloured lights used at sea. If the criteria of which he makes use are those I have supposed, it is to be expected that his capacity for the discrimination of differences of saturation, luminosity, and of such hues as he perceives, will be very greatly heightened, and I should be quite prepared to find that a colour-blind person may often be able to recognise a red, green, or white light even sooner than a normal person.

In the foregoing account I have attempted to describe the criteria whereby colour-blind and colour-weak persons are able to recognise the lights used at sea. I must again point out that this account is merely tentative, and that there is urgent need for an experimental inquiry to determine how far such an account is correct.

A few words may be said about the form which such an inquiry should take. It will probably be impossible to conduct this inquiry at sea, but it will be necessary to imitate conditions as they exist at sea, and there does not seem to me to be any serious difficulty in the imitation of fog and any other conditions which affect the vision of the lights used at sea. A more difficult matter is the imitation at close range of the coloured lights seen at a distance. The obvious way of imitating lights seen at a distance is the observation of the lights actually used at sea at a small visual angle, this being effected by means of diaphragms. There is, however, a source of fallacy in this method. A signal lantern, seen at close range, may be observed to differ in colour in the different part of its field. Thus, a blue-green signal will appear distinctly yellowish in the centre, corresponding to the position of the actual light, and blue-green in the periphery of the exposed field.

If a diaphragm be used, only the central part will be used, *i.e.*, a light will be presented which is far more yellow than the actual light, as it appears as a whole when seen at a distance. It seems to me probable that this fallacy has actually vitiated Nagel's observations (*see* p. 2); that he used lights much yellower (or less blue) than the lights as they would have been seen at a distance; and that this was so seems to be indicated by the fact (*op. cit.*, p. 470) that his subject saw all three of the lights used as yellowish.

Having now considered certain preliminary problems concerning the power of the colour-blind to recognise colour for practical purposes, I propose to consider briefly the nature of the coloured lights actually used at sea. So far as I am aware, the red lights thus used are relatively constant in hue. The glasses used, not only in our own marine, but probably universally, are distinctly on the yellow side; and whether the light behind it be more or less yellow, no difference will be produced in the hue of the resultant light. Probably there is not a single case at the present moment, in which the red light used at sea has other than a yellowish hue.

With the green light the case is very different. In our own marine and in that of Germany * the standard green glass is definitely blue-green—in fact, so blue a green that the man in the street would call it blue.

The actual colour seen at sea will, however, vary with the nature of the light exposed behind the glass; the relatively white electric or acetylene lights will give a resultant light differing in hue from that given by an oil lamp. I gather from the Board of Trade "Instructions as to the Survey of Light and Fog Signals" that attention is already paid to these points; but it is not clear that it is the business of the surveyors to see that the resultant light shall be definitely bluish. No exact measures appear to be taken to ensure the constancy in hue of the resultant lights, even in our own marine; but even if this should not be so, it seems quite certain that at the present time nothing is done to ensure

* I am indebted to the Board of Trade for the information that in Germany regulations have been issued "that the tint "of the port-side light should preferably be copper-colour, "and the tint of the starboard light should be bright blue "green, not yellowish green or grass green." The use of the word "preferably" suggests that the regulations ensure no great degree of constancy. At the time this information was given to me, the Board were not in possession of information concerning the nature of the standard lights used by other nations, but possibly this information has since been obtained.

constancy in the hue of the green light used by different nations, and it is possible that there are nations whose green lights are definitely yellowish. In my opinion a further urgent need is an inquiry into the actual regulations of different nations; an inquiry into the constancy in hue and intensity of the lights used at sea; and if, as will almost certainly be the case, they should be found to be inconstant, the first need will be to bring about an international agreement to ensure such constancy.

If experimental inquiry should show that the foregoing account is even approximately correct, it will be obvious that no condition is more important than constancy in hue of the lights used at sea. If, as is beyond all doubt, there are colour-weak and colour-blind persons holding responsible posts at sea, there can be little question that the use of a yellowish-green light is a serious source of danger. Further, it is only when the conditions with which colour-weak persons have to deal are known and constant, that any satisfactory conclusions can be reached concerning the degree of weakness which affects their competency. So long as the conditions with which colour-weak persons have to deal are inconstant, so long will even slight degrees of weakness be possible sources of danger. There are, however, two additional reasons which, in my opinion, make it imperative that the lights used at sea shall be standardised and rendered constant.

The first of these reasons is that the safety of a vessel at sea does not depend only on its own navigation; as has been said, it takes two vessels to make a collision. A vessel belonging to a nation, which does everything to exclude colour-blind persons, may at any moment have its safety endangered by the presence of a colour-blind person on the vessel of another nation. It is possible to make international regulations concerning the nature of the lights used at sea, but it will be quite impossible to insist that every nation shall take adequate steps to ensure the absence from its services of all colour-blind persons. It must be recognised that, whatever we do, colour-blind persons will continue to navigate vessels, and the danger arising from such cases will be far greater if the lights used at sea continue to be inconstant. It is certain that for many years colour-blind persons will be permitted to hold responsible posts at sea by some of the nations of the world, and that the safety of the vessels of other nations will be thereby endangered. If this be granted, it will hardly be possible to put on one side a practicable scheme for minimising this danger.

Another ever-present danger would also be met, at any rate to some extent, viz., that arising from the gradual onset of acquired defects of colour-vision (*i.e.*, from disease) in those already holding responsible positions at sea. Annual, or even more frequent, examinations, either of the form-sense or of the colour-sense itself, cannot wholly exclude this source of danger. Though acquired defects of colour-vision present greater variety than the congenital forms, there is little doubt that in the great majority of cases, and especially in the initial stages, the defect has the same general characters as in the congenital form, and a measure which assists the congenital cases would also assist the great majority of acquired cases. It may be pointed out that there are probably many persons, who suffer from slight weakness in central vision for red and green as the result of tobacco-smoking, who perhaps never reach the stage which would be called amblyopia. These undoubted dangers would certainly be greatly diminished, if the coloured lights used at sea were constant in hue and relative brightness.

One objection to the measure I propose may be mentioned. It may be objected that a red-green blind person is blind to the red in the proposed standard red light, and would therefore be altogether dependent on his recognition of its yellow component; and that similarly he would be blind to the green in the blue-green light and would be altogether dependent on its blue component; and that in consequence the hues in which these lights are seen can be of little service to him. This objection can only be fully met on the basis of actual experiment; but it may be pointed out, first, that it is probably a misconception to suppose that the coloration of the red and green lights, provided they are definitely yellowish or bluish, is any less vivid to a colour-blind person than to one with normal vision; and secondly, this objection ignores the increased capacity for discrimination which is a characteristic of colour-blindness. As I have already suggested, it is possible that, owing to this characteristic, a colour-blind person may even be able to recognise a red or green light (with the same proviso as above) before it has been recognised by one with normal colour-vision.

I advocate, then, the international standardisation of the lights used at sea for three reasons: firstly, in order to diminish the dangers arising from the presence of congenital cases of colour-blindness or colour-weakness at sea, a possibility which cannot be excluded in our own marine and certainly not in those of all nations; secondly, as a means of diminishing the dangers arising from the presence at sea of persons who have acquired defects of colour-vision, especially in the early stages of such defects when the sufferer himself is quite unaware of his condition; and thirdly, because it will be far easier to determine the degree of colour-weakness which should disqualify, when the conditions with which such persons have to deal are simple and constant, than when they are, as at present, complex and inconstant.

It is obvious that there is a still larger question. It is possible, if the conditions were standardised, either in the way I propose or in some other, that many cases even of colour-blindness might be allowed to hold responsible posts with safety, the only cases whose exclusion would be absolutely necessary being those with diminished luminosity of red. This question was considered by the Committee of the Royal Society (pp. 14–15). The Committee recognised that it was the green signal which raised difficulties, but assumed that it would be necessary to employ a blue glass for the second signal, in order that the two colours should be recognised by the colour-blind. It does not appear to have occurred to the Committee that the blue-green glass, which they proposed as the standard in the next paragraph of their report, might be amply sufficient to meet the requirements of colour-defective persons, if the standardisation were carried a step further.

It may seem premature to consider how the standardisation I propose may be carried out, but I do so briefly in order to meet possible objections on the score of impracticability. At the present time the Board of Trade only standardises the coloured glasses, and, as I have already pointed out, the effect of such standard glasses, on the actual light as seen, will vary greatly both with the hue and the intensity of the lights exposed behind the glasses. It will also vary with the thickness of the coloured glass. All that I propose is that, instead of standardising the glasses, it is the lights which are actually seen which shall be standardised. For this purpose all that would be necessary is to settle on the hue and intensity of a standard light, and it would then become the business of the manufacturers of the lanterns to adjust coloured glasses to the light in such a way as to match the standard. This would probably be done most easily by having coloured glasses of varying thickness, and using these empirically, till the requisite light is produced. One obvious difficulty is, that it will not be possible to ensure that the source of illumination shall always have the same intensity. Fortunately, this objection, though valid, becomes less important, when we consider that change of intensity with time will usually be in the direction of diminution, and that this diminution will only make the green light bluer and therefore more easily detected by the colour-blind.

I should like to point out that the essential step in the change I advocate, viz., the choice of a blue-green light of constant hue for the standard green light, has already been taken by Great Britain and Germany, and possibly by many other nations. It is possible that very little will have to be done to make such a choice universal. In this case there will only remain the standardisation of the light, rather than of the glass used to produce the light, and the settlement of the exact hue of this light.

It will have become clear that in my opinion no satisfactory conclusion is possible concerning "the "degree of colour-blindness in persons holding "responsible posts at sea, which causes them to be "incompetent to discharge their duties" till new investigations have been carried out to determine the powers of distinguishing coloured lights which such persons possess. Further, I hope to have shown that the whole problem would be greatly simplified, if the conditions with which colour-defective persons have to deal were rendered constant by international agreement. Cases of total colour-blindness and of diminution of the luminosity of red lights are obvious sources of danger, which I have not thought it necessary to consider; but with this exception all that can be said is that, so long as the lights used at sea are inconstant in hue, every case of defect in vision for red and green, even of slight amount, is probably a source of danger.

I do not consider in this report the second reference to the Committee concerning any alteration in the tests at present in force, since this question cannot be answered until the Committee has settled what degree of defect is to be a disqualification.

W. H. R. RIVERS.
Dec. 8th, 1910.



## APPENDIX E.

### MEMORANDUM ON DARK ADAPTATION.

*(Communicated by Professor Gotch.)*

It is a familiar experience that on coming from daylight into a darkened room there is at first great difficulty in seeing faintly illuminated objects which in a short time become plainly visible. This phenomenon is mainly associated with an alteration in the receptive structures of the eyes which gradually become "adapted" to the dark environment and are rendered much more sensitive to feeble light.

A further equally familiar experience is the visual confusion associated with a sense of dazzling glare, which occurs on coming suddenly from a dark room into bright daylight; this also passes away as the eyes return to their daylight state of adaptation.

#### *The Structural Condition of the Eye in Dark Adaptation.*

(1) The eyes in the dark differ from the same organs in daylight in two respects, both of which increase the sensitiveness of these sense-organs to feeble light: the first is the dilatation of the pupils, allowing more light to reach the sensitive surface (retina); the second is a peculiar alteration in the retina and in the sensitive structures which it contains.

(2) The cellular elements of the retina which form the peripheral sensitive structures are of two types, cones and rods. These lie on the most posterior (deepest) border of the retina, where they are embedded in pigment cells; they have stalks connecting them with more anterior layers of the retina. In man the centre of the retina (corresponding with the centre of the field of vision) contains scarcely any rods. This central part (fovea) is crowded with cones; it occupies an area of relatively small size, so that when one luminous point is focussed in the middle a second point would be focussed on the edge of this region when the two points subtend an angle of $1\frac{1}{2}°$ to $2\frac{1}{2}°$.

Around the edge of this region the retina contains both rods and cones, which soon become almost equally numerous for some little distance (probably for 2° or 3°). This part may be termed the parafoveal region, and shades off into the remaining peripheral parts of the retina, in which the cones are greatly diminished in number and the rods greatly increased, until finally only rods are present.

(3) In a large number of vertebrates, particularly in many birds and fishes, pronounced changes in the form of the individual cones and rods have been found when eyes previously exposed in daylight are compared with those previously kept in darkness. With daylight the anterior stalks of the cones are diminished in length so that the cones are brought forward nearer the source of light, whilst the stalks of the rods are increased in length so that the rods are thrust back further from the source of light. Moreover, a third set of elements, cells containing pigment, is affected by light, the contained pigment streaming forward in large quantity until it forms a screen immediately behind and around the cones, and thus lies *en masse* between these and the lengthened rods. Similar changes, on a reduced scale, have been observed in many mammals, including the monkey, and probably occur in man.

All the above changes are reversed in the case of eyes kept previously in the dark. Hence, in the daylight eye the cones are more favourably situated, but the rods less favourably situated, for stimulation by light, whilst in the dark adapted eye the rods are at least as favourably situated as the cones. The rods are probably more readily acted on by weak light than the cones, since they contain a special pigment (visual purple) which is a sensitive photochemical compound; and the visual purple alters to light, particularly when this is of sufficiently short wave-length; thus red rays are nearly ineffectual, whilst green and blue rays cause marked changes.*

(4) The above facts, taken in connection with the peculiarities of vision in the dark-adapted eye, with the very scanty number of cones in night birds (owls, &c.), and with the very scanty number of rods in day birds, suggested to von Kries his hypothesis as to the different functions of the two structures. According to this the cones are the sensitive structures aroused by all visible light waves giving rise to the ordinary colour sensations (and in combination to white), whilst the rods are extremely sensitive to all light waves of sufficiently short wave-length, and give rise to sensations not of colour but of various shades of white. These come into play in the peripheral parts of the dark adapted retina, increasing the perception of faintly luminous objects, but without giving rise to distinctive colour sensations.†

#### *The Peculiarities of Visual Sensations in Dark Adaptation.*

(1) *White Light* subtending large areas (5° or more) may be perceived at night or in the dark room when the light itself is even several hundred times less in intensity than the minimum low limit which can be perceived by the light-adapted eye. This great increase in sensitivity is not shared equally by all parts of the retina, for if white light subtending small angles (30″ or less) is employed, it is found that on the centre of the field of vision (fovea) the increased sensitivity is comparatively slight, but on the peripheral parts of the visual field it is very marked. Thus a feeble star, scarcely visible when looked at directly, becomes bright when the visual gaze is directed to another star a little way off, in which case the image of the star is focussed several degrees outside the centre of the retina.

(2) *Coloured Lights.*—In the dark-adapted eye the stimulation by coloured light of the extra foveal part of the retina, containing a considerable amount of rods, gives rise to peculiar modifications of visual consciousness.

(*a*) On looking directly or a little obliquely through a spectroscope of wide dispersion in a dark room at a

* *See* Garten, "Die Veränderungen der Netzhaut durch Licht," Handbuch der Gesamten Augenheilkunde. Teil I., Band III., Kapital XII., Ankang (1907–08), (Leipzig).

† *See* article by von Kries, "Die Gesichtsempfindungen" in Handbuch der Physiologie. Nagel, Band III., 168–202 (Braunschweig), 1905.

very faint source of light, visual sensations of a uniform character as regards colour are produced when the eyes have become sufficiently dark adapted. The spectrum may finally appear as a grey white band, with its brightest part in the region which under ordinary conditions would appear blue-green. No light at all or a mere fringe of dark grey is seen in what would correspond with the red end, whilst the part which corresponds with yellow appears as a rather dull grey.

(*b*) If the eye is fixed in the dark room on one small spot of light and a second small coloured light is flashed out at some little distance, then the sensation produced by this varies with the position and hue of this second light.

If the second light is spectral green or blue, and is some degrees away from the first light (this last being fixed by the visual gaze and thus in the centre of the field of vision), the second light gives rise to a sensation of rather dazzling white. This is especially the case when the light itself is of very small angular area. The sensation continues when the second light is moved nearer the first, and tends to mask any recognition of green or blue colour. In my own case such colour recognition may not occur with the Board of Trade light green light until this is focussed on the retina within 1½° to 2° from the centre when the dazzle disappears and the colour becomes quite plain.

If the second light is red, then neither the colour nor the light itself is recognised when it is so situated as to be focussed on the retina over 8° or 10° outside the central fixed one. In my own case with a dim Board of Trade light red, the limit of failure of colour recognition was a little under 6½°. Beyond such recognition limiting distance there was no sensation of white dazzle, but a barely perceptible dull grey spot was sometimes seen instead of the red light. Further out this light became quite invisible. When brought as near as 6° it always showed as a distinct red spot, and continued so however close it was brought. There was no simultaneous white dazzle to mask the hue; thus the light, if visible, was easily recognised.

A number of experiments on individuals ascertained to possess normal colour vision support the view that, in the dark-adapted eye red light is recognised as red over an area whose radius is three or four times that observed with green light; yet the red light is not seen at all outside this larger area. On the other hand, green (or blue) light, whilst it is only recognisable as green over the much more restricted central area, is seen as a bright light of a dazzling white type over a very extensive area.

As illustrations of such visual phenomena in connection with what is termed "dark adaptation perimetry," I append a few experimental results obtained from ten different observers, all with normal colour vision.

| Number of Observer. | Angular Distances from Centre within which the Colour of a Spectral Light 30″ Diameter was recognised. | |
|---|---|---|
| | Red Light (6563λ). | Green Light (5169λ). |
| 1 | Within 6° or 7° | Within 1½° or 2° |
| 2 | ,, 7½° ,, 8½° | ,, 1½° ,, 2½° |
| 3 | ,, 9° ,, 10° | ,, 2½° ,, 3½° |
| 4 | ,, 6° ,, 7° | ,, 2° ,, 2½° |
| 5 | ,, 7° ,, 8° | ,, 2° ,, 3° |
| 6 | ,, 8° ,, 9° | ,, 2° ,, 2½° |
| 7 | ,, 8° ,, 9° | ,, 2½° ,, 3° |
| 8 | ,, 8½° ,, 9½° | ,, 2½° ,, 3° |
| 9 | ,, 6° ,, 7½° | ,, 2° ,, 2½° |
| 10 | ,, 8° ,, 9° | ,, 2° ,, 2½° |

It may be added that with the red spot of light any recognition of light immediately beyond the sensitive limit given above was very doubtful or non-existent, although with practice a dull grey spot can be perceived for a short distance. On the other hand, with the green spot of light there was, from 3° outwards, most definite recognition of light over a very large area, the appearance being a white or bright dazzle. This was also present with blue light, but the hue was unrecognisable as regards both blue and green. Yellow light also gave the same bright dazzle; it was often blended with a reddish sensation if it lay from the centre about 3° or 4°.

(3) The recognition of small areas of red or green by the dark-adapted eye is, as regards colour, thus only possible when these are focussed near the fovea, *i.e.*, lie near or at the centre of the field of vision. This is particularly the case with the peripheral vision of green; presumably these rays, by exciting rods, evoke a sensation of white, which has a dazzling effect and masks the true colour. Such white dazzling sensation is still present, but to a less degree, as the green light approaches the centre of the field of vision, but it ceases when this light is 1° to 2° from the centre. According to von Kries the explanation is the differential stimulation of both rods and cones, that of the rods giving rise to the dazzling white sensation in addition to the colour sensation produced by the stimulation of the cones.

*The Picking Up and Recognition of Distant Lights at night.*

(1) The eye being dark adapted, the foregoing peculiarities of visual sensations must affect the recognition of coloured lights at night.

(*a*) *White or yellowish Distant Lights.*—At sea on a dark night there are no obvious distant objects to definitely fix the visual gaze, and the eyes wander searching the horizon. Attention will be first attracted during this search, when a distant small white light is so situated with regard to the visual gaze as to be looked at somewhat obliquely; it may then appear quite bright. The eyes will now turn towards its source, so as to bring it into the centre of the field, but since this central region is in the dark-adapted eye much less sensitive than the peripheral part, the light will become dim and may even be invisible. By means of a binocular, it will become visible and be recognisable at once as a small white or yellowish light. The dark adaptation must thus facilitate the picking up of small distant white lights at sea, owing to the great sensitiveness of the peripheral parts of the retina containing rods which, by dark adaptation, are favourably placed for stimulation.

(*b*) *Green* (*blue*) *Light.*—As in the previous case the eyes in their search will be first effectually stimulated, if a distant small green light is looked at obliquely and its image is thus focussed on parts of the retina lying outside the fovea, *i.e.*, centre of the field of vision. A visual impression of a rather dazzling white light will now attract the attention. On gazing directly at the suggested position of the source, it is very probable that no light will be seen, but if it falls on the retina a little way off the centre of the field, it will reappear and give a confused blend of white dazzle with a greenish tinge. The resemblance to white or yellowish distant light will now confuse the judgment, and this confusion will continue until the light grows sufficiently bright by coming nearer as to be seen in the centre of the field of vision, when it will appear an unmistakeable green. By means of a binocular this last result is more easily achieved and recognition is more undoubted.

(*c*) *Red Light.*—In this case the image of the light must fall within about 10° of the middle of the retina to arouse any sensation, and on attention being then directed to it such light will appear unmistakeably red. In as much as there is no white dazzle sensation to confuse the judgment, both the picking up and the recognition are approximately simultaneous, and both are favoured by the comparatively large retinal area, 16° to 20° in diameter, within which the red response can be evoked.

Experiments seem to show that in some individuals with normal colour sensations the size of this area may be considerably reduced; in these cases there might be more difficulty in picking up a distant small red light.

(2) From the above differences between red and green recognition in the case of small distant lights, the conclusion may be drawn that accurate focussing, whilst an important factor in all colour recognition, is particularly important for the recognition by the dark-adapted eye of distant small green lights. These must be accurately focussed upon a relatively small area around the centre of the retina if they are to produce the appropriate colour sensation, otherwise they will always produce an extensive white dazzle which must more or less mask the colour and confuse the visual judgment. In practice the use of binoculars is probably relied upon for recognising the hue of distant coloured lights of small area, but a possible aid to such recognition is the circumstance that in any doubtful case if the light, apart from its colour, is better seen by oblique than by direct vision then it is green or white, if better by direct than oblique vision then it is red. Thus it has been shown that the French red ship-light is visible on the centre of the visual field twice as far as the French green ship-light, but the French green ship-light is seen as a white dazzle in the outer field of vision four to five times as far as the red is on the centre of the field.*

*Dark Adaptation in Colour-Blind Individuals.*

The phenomena of dark adaptation occur in colour-blinds as in normal individuals. It is the cones not the rods which, on von Kries' hypothesis, are the first links in the chain from the retina to visual-colour consciousness. In accordance with this conception it is most improbable that dark adaptation should assist colour recognition in cases of colour blindness or colour deficiency. It may, indeed, be inferred that dark adaptation, instead of giving any perceptible assistance, would increase the inability of the colour-blind to recognise some given colour when other clues derived from extraneous sources of light are removed by the dark environment.

Supposing, however, that there is a certain deficiency or weakness in red recognition, this will involve more practical incapacity in the dark adapted state than a similar weakness or deficiency in green recognition, for a distant small red light evokes a response when it falls upon the less sensitive parts of the dark adapted retina and with weak reacting power to red, this kind of light might be thus either invisible or a dim grey. The ship signal red has moreover a yellow portion which may evoke a white sensation such as is caused by green of low luminosity, and thus be confused with a dim green.

Considerable green deficiency must be serious, but from what has been already said as to the difficulty of recognising this light in the dark-adapted eye, when small dim lights are observed, it is probable that persons, with clearly indicated but not marked green deficiency, may when dark adapted be not much worse off than normal individuals as regards failure of colour recognition. Even normal observers, when dark adapted, may have to form judgments as to the hue of distant small green light, after taking into account the white dazzle, which such a light may show, if viewed obliquely. It is not improbable that the green weak individual may come to rely upon this peculiar white dazzle, and through experience may be able thus to draw correct conclusions as between green and red lights. There will, however, be a great tendency for such an individual to confuse a green with a yellowish-white light since both of these might give a white dazzle without any tinge of colour.

* *See* Broca et Polack. Comptes Rendus, CXLV. July to December 1907, p. 828. (Paris.)



## APPENDIX F.

REPORT by the DIRECTOR of the NATIONAL PHYSICAL LABORATORY (Dr. R. T. GLAZEBROOK, F.R.S.) and Mr. C. C. PATERSON to the COMMITTEE on SIGHT TESTS, made at their request.

(1) PRELIMINARY EXPERIMENTS on the effect of using SPECTACLES in the OBSERVATION of POINT SOURCES of LIGHT.

(2) NOTE on an APPARATUS for MEASURING VISIBILITY and its POSSIBLE USE for TESTING ACUTENESS of COLOUR VISION in the OBSERVATION of POINT SOURCES of LIGHT.

*Part* 1.—*Experiments on the effect of using Spectacles in the Observation of Point Sources of Light.*

*Preliminary.*—The investigation described here is only in its initial stages and cannot be regarded as in any way complete. It is of little use, therefore, at this stage to do more than give the results of the experiments which have been made up to the present, without attempting to discuss any theory which would explain the phenomena observed.

Tests on ships lanterns were started about 12 months ago with a view to determining what laboratory tests were possible on them in order to certify their compliance with the statutory regulation respecting visibility.

Besides tests on the vanishing point of distant lights, measurements of their actual visibility were made by means of an apparatus to be exhibited on October 6th and described in the second portion of this report.

This apparatus enabled experiments in visibility to be carried out in a dark room in the laboratory by substituting a very small illuminated pinhole for the distant source of light. The pinholes used varied in diameter from about 0·2 m.m. down to 0·01 m.m. giving a range of from 1 millionth of a candle to 200 millionths of a candle.

In the use of this apparatus, as well as in the vanishing tests, it was soon apparent that distant lights, irrespective of colour, were much more visible to some observers than to others, and that point sources of light mainly green, which were visible to an observer with slightly imperfect sight, became invisible, or far less visible, when observed through spectacles which corrected his sight in the ordinary way. There appeared to be no obvious explanation for this phenomenon, and experiments were made in order to obtain data on the point.

*Experiments.*

*Series No.* 1.—The first set of experiments was made with two point sources of light consisting of pinholes placed in front of the steady flames of lamps burning a paraffin fuel. The beam of light from one of these pinholes could be continuously varied in intensity. It was placed at 2 metres' distance from the observer, and formed a variable standard against which the distant point source could be matched. The distant point source was placed at positions varying from 170 metres to 3 metres from the observer, and a series of comparisons made of its visibility against the standard pinhole. The beams of light from the two pinholes were brought side by side in the field of view of the apparatus so that both sources could be readily compared with the same eye.

It should be remarked, however, that as yet each observer used only one eye instead of two as in ordinary vision, and apparatus is at the moment under construction to allow of the use of two eyes.

The observations up to the present have only been made by two observers: Mr. C. C. Paterson, who ordinarily wears spectacles to correct for vertical astigmatism (+ 0·75 dioptre in the case of the eye used), and Mr. Dudding, whose sight is exceedingly

good. Mr. Paterson took observations both with and without spectacles.

The results of the tests are shown graphically in *Diagram No.* 345, which accompanies this Report.

In the upper curve the distant source was green, whilst in the centre and lower curves it was red and white respectively.

On the horizontal scales are plotted the distances of the distant source from the observer, whilst the vertical scale represents its visibility expressed in terms of micrometer candles of the standard pinhole.

It will be found that each curve closely follows the square law, showing that, over the distances used, visibility of a source varies inversely as the square of its distance from an observer. The point, however, of immediate interest is that in each case C. C. Paterson saw the distant source from 30 per cent. to 50 per cent. less bright when using his spectacles than when observing without them. This is the more unexpected since both spots of light being in the same field of view were observed simultaneously, but nevertheless the spectacles seem to differentiate against the one which is more distant.

It may be argued that the effect of glasses is to increase the visibility of the nearer source rather than dimming the distant one, and in order to decide this point a second series of comparisons between two point sources was made.

*Series No.* 2.—In this case one of the point sources was arranged so that it could be viewed through spectacle lenses. The other (standard) source was seen near to it but not through a lens. A series of spectacle lenses was used in front of the first source, varying in steps of 0·25 dioptre from + 1 to — 5. A very great falling off of visibility was found by both observers when viewing through a positive lens, whilst a gradual diminution, but not serious for practical purposes, took place with negative lenses when the source used was beyond the range of accommodation. Both observers found a maximum visibility between about 0 and — 1·0 dioptre.

The results of the tests are shown graphically in the upper curve on *Diagram No.* 346 which accompanies this Report. This gives the results of measurements in which the one source (viewed through a lens) was 15 metres away from the observer. The power of the lenses (in dioptres) is plotted horizontally, whilst the vertical scale represents the visibility of the distant source as viewed through the lenses. An inspection of the curves shows that Mr. Paterson saw only 15 per cent. of the distant light when viewing it through a one dioptre positive lens, whilst Mr. Dudding saw 28 per cent. under the same conditions.

It was thought that the phenomenon observed might be a function of accommodation, and the above experiments were repeated with the distant source respectively 9 metres and 1 metre from the observer; the standard comparison source remained throughout at a distance of 2 metres from the observer.

The results are shown graphically in the centre and lower diagrams on diagram 346. These curves have the same general characteristics as the first one, except that the nearer the source to the observer, the sharper is the falling off of visibility with negative lenses. With positive lenses the diminution seems to be much the same in all cases beyond one or two metres. Different pinholes were used in the three tests so that the actual scales of visibility in the three curves are not of importance, except as showing the relative degrees of brightness of the source in the three experiments.

Too much weight must not be attached to deviations from a smooth curve in these diagrams. The general shape of the curves can always be repeated, but there is as yet no evidence that an observer will, on two different occasions, exactly repeat the shape of a curve.

A correction has been applied to some of these readings, due to the fact that, by the ordinary laws of transmission through lenses, the image of the spot of light on the retina will be increased or diminished in intensity due to the distance of the lens from the eye becoming in some instances comparable with that from the source to the eye. The change of visibility shown in the curves is therefore entirely due to some as yet, unknown cause. It appeared that the cause may have some relation to the accommodation of the observer's eye, and a further test was made on the following lines.

*Series No.* 3.—The standard variable source was set up so that it could be observed through the lenses. Its intensity was then cut down by means of a sector disc until an observer considered that it had vanished from direct vision. It is not easy to say with certainty when a spot has vanished, but the readings obtained by both observers were fairly concordant. They showed that when either observer endeavoured to focus a spot on his fovea its vanishing point varied according to the lens used, in the same kind of way as in the previous experiment. If, however, instead of endeavouring to focus the image, the observer looked at the spot obliquely so that its image fell on the outlying portion of the retina there was no progressive change of vanishing point according to the lens used, but the vanishing point remained about constant. This experiment has yet to be repeated and checked under other conditions, and is only mentioned here as an indication of the direction in which a solution may be found.

*Experiments at 2 Miles.*—The above experiment appeared of considerable importance from the point of view of the practical observation of lights at sea, and some preliminary experiments were made on a 2-mile range. The Committee is familiar with the phenomenon, that whereas a white light can be seen on the outlying portions of the retina long before it can be seen by direct vision, the red light is seen by direct vision before it can be noticed by oblique vision. On the other hand, the green light is relatively even more visible than the white light to oblique vision. Now of the green and red glasses used in practice, the green absorbs by far the greater amount of light, so that for lamps of equal power, if the green is visible the red is easily so. Thus the green light is the important one to consider, and the experiments at 2 miles showed that in the case of Mr. Paterson, spectacles made practically no difference to the brightness of the green light when viewed obliquely, but only when viewed direct. Hence, an observer wearing spectacles, such as Mr. Paterson's, would be expected to "pick up" a green light as well as one who did not wear them, the only difference arises when the image is focussed on the fovea.

Incidentally, it may be mentioned that the vanishing point of a point source of white light when focussed on the fovea is equivalent to a light of the order of one ten-millionth ($\frac{1}{10000000}$) of a candle at a meter distance. When viewed by the outlying portions of the retina it is equivalent to about a 50 millionth ($\frac{1}{50000000}$) of a candle at a meter distance.

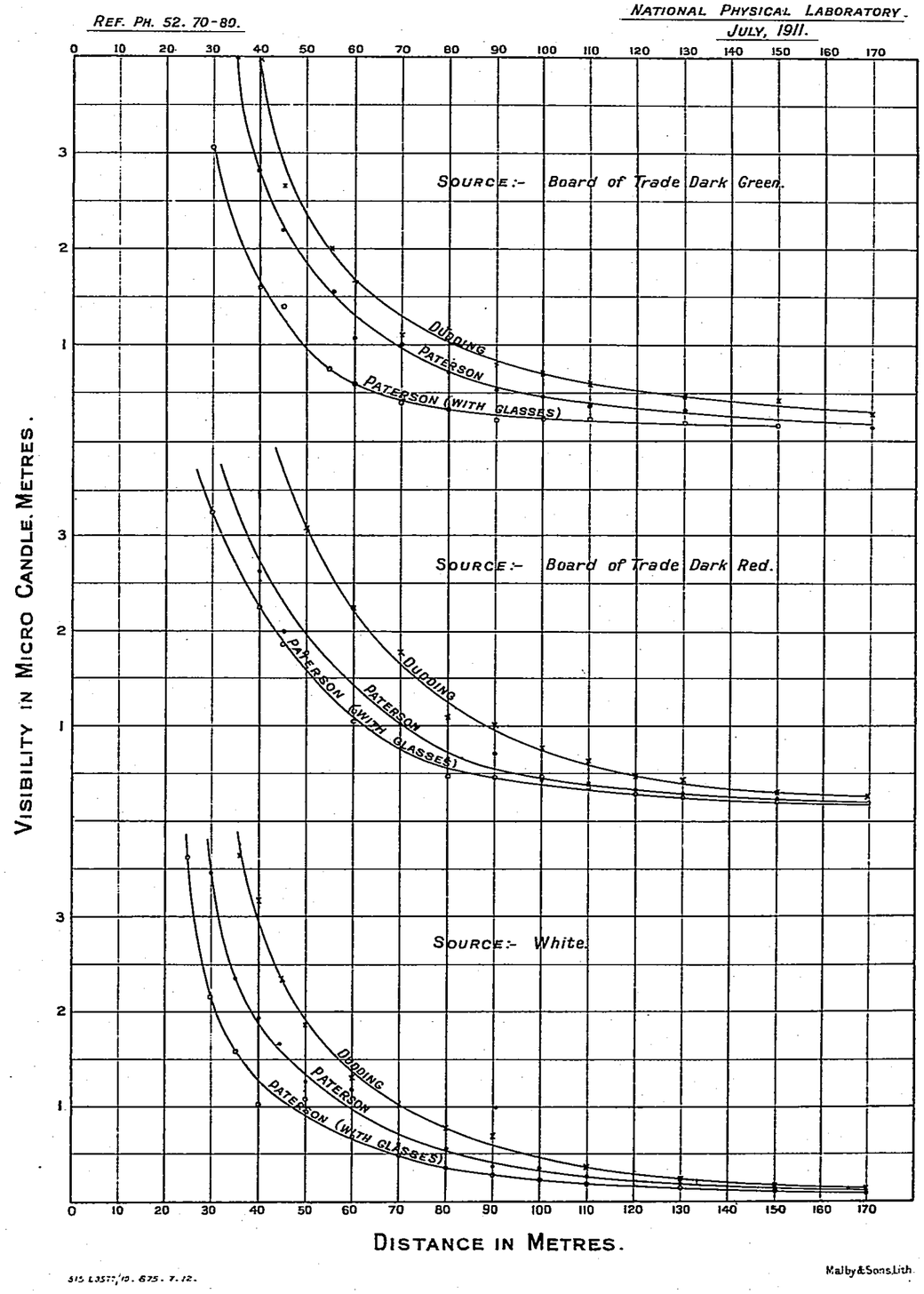
### *Part 2.—Apparatus for measuring Visibility, and its possible use for testing acuteness of Colour Vision in the Observation of Point Sources of Light.*

The apparatus referred to in the first portion of this Report is exceedingly simple. It consists merely of a tube about 2 metres long. One end of this tube is closed except for a small aperture over which a brass disc can be fixed containing at its centre a very small pinhole. The usual size of pinhole employed is of the order of 0·1 m.m. diameter. A paraffin lamp is placed behind this pinhole and the beam of light from it passes to the other end of the tube and is there reflected upwards to the eye through an observation tube. On its way the beam passes through adjustable absorbing wedges so that its intensity may be varied at will. The beam from the distant light to be observed is also reflected up the observation tube in such a way that its image is seen by the side of the other one, a comparison between the two being readily made.

The distant light can be replaced by an illuminated pinhole of suitable size and the apparatus used in a dark room in the laboratory. By placing red or green glasses in the path of the beam from one of the pinholes and by adjusting the brightness suitably, the arrangement may be made to represent the appearance of a ship's lights at sea. That is to say, a point of light representing the masthead lamp is seen alongside of a

## DIAGRAM Nº 345.

## CURVES SHOWING THE VARIATION OF VISIBILITY TO DIFFERENT OBSERVERS OF A POINT SOURCE OF LIGHT AT DIFFERENT DISTANCES.



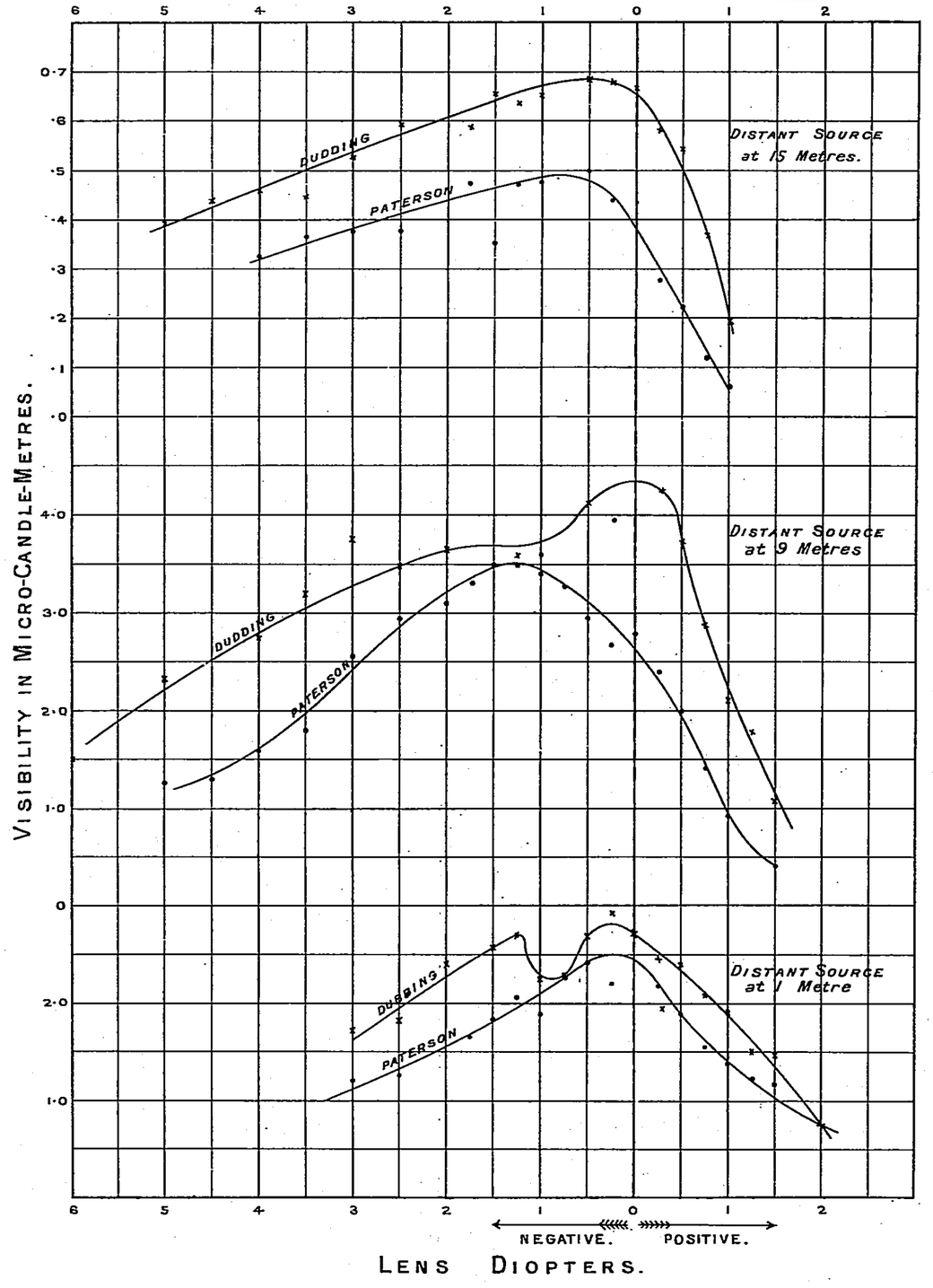

S15 L3577/10. 675. 7. 12. Malby & Sons, Lith.

## Diagram No. 346.

### Curves showing the Variation of Visibility of a Point Source of Light viewed through Spectacle Lenses of Different Power.

REF. PH. 52 A.

NATIONAL PHYSICAL LABORATORY, SEPT 1911.




815.L3571/10. 875. 7.12.

Malby & Sons Lith.



green or red light on a black background. The masthead light can, if desired, be cut off altogether and a green or red speck of adjustable brightness can be viewed alone on a dark field, the speck of light being reduced if required to the vanishing point.

Up to now the apparatus has been for observations with one eye only, but it is expected that an instrument will be ready for showing to the Committee in which ordinary vision with two eyes is possible.

It is suggested that an apparatus of this nature would be very suitable for use as a practical test for the eyesight of seamen and others.

(Signed) R. T. Glazebrook, Director.

C. C. Paterson

September 16th, 1911.

## APPENDIX G.

### The Liverpool Steam Ship Owners' Association.

Summary of the Information, obtained from the individual Members of the Association, on the Points referred to in the Letter of the 31st July, 1910, addressed by the Secretary of the Sight Tests Committee to the Association.

*1st Point.—Any instances within your knowledge of mistakes being made in the reading of lights at sea, which may have been due to defective form or colour-vision.*

*2nd Point.—Any cases in which a man suffering from defective vision, without making a definite mistake, has found difficulty in reading signals; or, alternatively, has been able to prove that in practice he found no such difficulty.*

The undermentioned members of the Association reply that there are no such instances within their knowledge:—

| Names of Members. | Vessels owned or controlled by Members. | |
|---|---|---|
| | No. | Gross Tonnage. |
| Allan Brothers & Co., U.K., Ltd. | 52 | 275,817 |
| American Line | 10 | 100,508 |
| Anchor Line | 19 | 107,143 |
| Bacon, John, Ltd. | 8 | 5,548 |
| Bates, Edward, & Sons | 6 | 34,969 |
| Belfast S.S. Co., Ltd. | 7 | 9,274 |
| Bibby Bros. & Co. | 7 | 48,894 |
| Brocklebank, Thos. & Jno., Ltd. | 9 | 56,047 |
| Chadwick, Joseph, & Son | 6 | 26,026 |
| Chambers, James, & Co. | 9 | 36,859 |
| Crow, Rudolf, & Co. | 5 | 21,213 |
| Cunard Steamship Co., Ltd. | 22 | 216,659 |
| Currie, Donald, & Co. | 9 | 13,039 |
| Dominion Line | 13 | 82,619 |
| Dublin & Liverpool S.S. Co., Ltd. | 2 | 917 |
| Dundalk & Newry S.P. Co., Ltd. | 5 | 2,721 |
| Elder Dempster & Co. | 113 | 346,138 |
| Ellerman Lines— | | |
| Hall Line | } 48 | 162,447 |
| Ellerman Line | | |
| Papayanni Line | | |
| Fletcher, G. H., & Co. | 2 | 4,014 |
| Fletcher, J. T., & Co. | 9 | 12,210 |
| Glynn, J., & Son | 10 | 26,540 |
| Harrison, T. & J. | 41 | 210,067 |
| Holt, Alfred, & Co. | 62 | 350,852 |
| Hough, Samuel, Ltd. | 4 | 5,414 |
| Hoult, Joseph, & Co., Ltd. | 10 | 28,959 |
| Houston, R. P., & Co. | 24 | 90,803 |
| Ismay, Imrie, & Co. | 32 | 373,907 |
| Johnston, William, & Co., Ltd. | 19 | 78,106 |
| Lamport & Holt | 29 | 132,211 |
| Langlands, M., & Sons | 12 | 10,940 |
| Leyland, F., & Co., Ltd. | 35 | 208,857 |
| Liverpool & North Wales S.S. Co., Ltd. | 6 | 3,615 |
| Lloyd, Hy., & Co. | 1 | 2,830 |
| MacIver, David, & Co. | 7 | 24,217 |
| Mack, J. J., & Sons | 7 | 3,492 |
| Moss Steamship Co., Ltd. | 13 | 33,474 |
| Nicholson, R., & Sons | 5 | 17,265 |
| Orford, T., & Sons | 11 | 16,626 |
| Carried forward | | |

| Name of Members. | Vessels owned or controlled by Members. | |
|---|---|---|
| | No. | Gross Tonnage. |
| Brought forward | | |
| Pacific S.N. Co. | 43 | 182,348 |
| Powell, F. H., & Co. | 9 | 8,625 |
| Rankin, Gilmour & Co., Ltd. | 15 | 59,260 |
| Rea, R. & J. H. | 6 | 12,070 |
| Royden, Sir T. B. | 12 | 64,603 |
| Serra S.S. Co. | 13 | 27,269 |
| Stott, W. H. & Co., Ltd. | 4 | 6,419 |
| Strong, Reid & Page | 2 | 4,251 |
| Tedcastle, McCormick & Co., Ltd. | 6 | 4,299 |
| Thin, E. C. | 3 | 13,356 |
| Thompson, Anderson & Co. | 2 | 7,207 |
| Thomson, W. & R. | 6 | 23,595 |
| Turner & Co. | 16 | 65,409 |
| Warren, George, & Co. | 4 | 23,519 |
| Waterford S.S. Co., Ltd. | 4 | 4,049 |
| Watts, Watts & Co., Ltd. | 3 | 11,341 |
| Welsford, J. H., & Co., Ltd. | 7 | 32,340 |
| Wilson, Son & Co. | 8 | 12,280 |
| Total | 857 | 3,776,695 |

The only instances given by any members are the following:—

(1) *The Marine Superintendent of Yeoward Bros.* (who own four steamers of 5,981 gross tonnage) reports:—

"In reference to 'Colour-Vision,' in my seagoing capacity I have come across several cases of defective vision; the most prevalent error appears to be the mistaking of the port light, during rain or misty weather (when the brilliance of the red light is dimmed) for green. The danger of this particular mistake is apparent. I have only noted one case of defective form-vision, due entirely to excessive indulgence in spirits. Although a large number of officers require spectacles to read, I have never known any to be deficient in picking up lights, &c., while on watch."

(2) *Messrs. Larrinaga & Co.* (who own 16 steamships of 64,819 gross tonnage) report:—

"In a case lately an officer was refused by the Board of Trade, but his captains before and since say they have every confidence in his ability to distinguish colours in actual practice, and that he finds no difficulty in doing so."

(3) *Captain C. d'H. Bell* (the City of Dublin S.P. Co., who have entered in this Association six steamers of 7,654 gross tonnage) reports:—

"We have an officer who has failed to pass in form vision, both in Dublin and when specially examined in London, but is reported to have good sight for practical work at sea by the captain he has served under. He failed to read the fifth line on the test card."

(4) *The Booth S.S. Company, Limited* (who own 33 steamships of 120,970 tons gross), report:—

"It has been found, in two cases in officers of this company, that they are unable to pass the test specified under head 3, but in actual practice (*i.e.*, a trip over the river in a ferry boat) they are able to distinguish quickly enough all necessary signals and lights."

*3rd Point.—Any tests which you require your officers to undergo which are not imposed on them compulsorily by the Board of Trade.*

The undermentioned members of the Association, who own or control 259 vessels of 1,730,189 gross tonnage, require their officers to undergo the undermentioned examinations, and report as follows:—

(1) *Messrs. Alfred Holt & Co.* (who own 62 steamers of 350,852 gross tons) report as follows:—

"We have our own private tests, in addition to that used by the Board of Trade, and we consider them rather more stringent."

(2) *The Marine Superintendent of the Cunard Steam Ship Co., Ltd.* (who own 22 steamers of 216,659 gross tons), reports:—

"We require from all our officers, other than captains, a test certificate from the Board of Trade every year. This has been in vogue some four or five years, and when first introduced one officer failed to pass the test and had to resign from the sea in consequence of having his certificate endorsed."

(3) *The Dominion Line* (who own 13 steamers of 82,619 gross tons) report:—

"Our officers are examined by our own medical officer annually for form and colour-vision, but the distance test is only half the distance required by the Board of Trade, and the colour test is by card and not by Holmgren's wools."

(4) *The American Line* (who own 10 steamers of 100,508 gross tons) report the same as the Dominion Line.

(5) *The Booth Steamship Co., Ltd.* (who own 33 steamers of 120,970 gross tons), report:—

"(i) All captains are required to pass the special test of the Company at least every three years, and

"(ii) All officers, every two years.

"The test is as follows:—

"(*a*) To distinguish black dots $\frac{1}{10}$ inch diameter on a well illuminated white surface at a distance of 15 feet, each eye being tested separately. *In new men* there must be 100 per cent. of vision in one eye and not less than 50 per cent. in the other. *In old men* (old in service, not in years) 50 per cent. of decrease in both eyes entails a test of moving shipping on the river.

"(*b*) Colour-blindness is tested by the lamp with various modifying glasses simulating mist, rain, and fog. No hesitancy must be shown in distinguishing between red, green, and purple, even when combined with these modifying glasses.

"The wool test has, in the experience of this Company, failed completely to detect colour-blindness, whereas the lamp with the modifying glasses will always catch a colour-blind man."

(6) *The Marine Superintendent of F. Leyland & Co., Ltd.* (who own 35 steamships of 208,857 tons gross) reports:—

"The officers are tested by our medical officer every year for sight by Snellen's card, but at half the distance required by the Board of Trade, and for colour he tests them on the coloured card 'after Holmgren.' He does not use the wools."

(7) *The Marine Superintendent of Allan Bros. U.K., Ltd.* (who control 52 steamships of 275,817 tons gross), reports:—

"Coloured lamps—also coloured discs, as set forth by Board of Trade Regulations."

(8) *Messrs. Ismay, Imrie & Co.* (who own 32 steamships of 373,907 tons gross) report:—

"Commanders and officers have to pass every two years, consequently these examinations should be of a practical nature."

The officers of the undermentioned members, who are the owners of 50 vessels of 52,872 tons gross, are, as holders of Mersey Pilotage Certificates as pilots, examined by the Pilotage Committee of the Mersey Docks and Harbour Board every two years:—

*Waterford S.S. Co., Ltd.*
*F. H. Powell & Co.*
*M. Langlands & Sons.*
*Liverpool and North Wales S.S. Co., Ltd.*
*R. and J. H. Rea.*
*Tedcastle, McCormick & Co., Ltd.*
*Belfast S.S. Co., Ltd.*

The other members of the Association, owning or controlling 607 vessels of 2,193,058 tons gross, require no special tests.

## APPENDIX H.

### Memorandum on the Case of a Colour-Blind Naval Officer.

*Communicated by Mr. Nettleship.*

A gentleman who had many years' experience in one of the European navies, and is both colour blind and has defective form-vision, furnished the following information with regard to his own experience. On first going to sea he always found himself very slow in picking up small objects by sight, *e.g.*, buoys, though once seen they were plain enough so long as he kept his eyes on them. He was always very inaccurate in taking observations of the sun and stars with the sextant. He always found difficulty with the coloured lights: unless quite close he could not tell whether the light was white, red, or green; and the difficulty was particularly great in discriminating between white and green. However, he managed all right for observing the rule of the road, as except on a very dark night he was able with night glasses to distinguish the form of the hull of a vessel which usually had other lights showing on board. Also the fact that merchant steamers usually carry their coloured side lights well abaft the white steaming light enabled him to judge how the ship was steering. He adds that he was also able to ask any other person present what he made of the light, and having settled that point, he, of course, knew how to act. He did not, however, put down these difficulties to defective vision, as he supposed that the difficulty he experienced was experienced by everybody. On one occasion, when aged about 20, he was in charge of a torpedo boat forming one, about the centre, of a group of several, passing in single file at night practice up an estuary. The signal to stop engines and anchor was given by an arrangement of the three coloured lights (white, red, and green) displayed by the leading vessel. When this signal was given he was unable to interpret it, and had to sheer his boat off to one side to avoid a collision. He had not then realised fully his colour blindness and thought the mistake due to want of practice.



A few years later he noticed other difficulties—difficulty in reading the colours of flags hoisted by other vessels, in seeing objects ashore, or even the white towers of a conspicuous lighthouse from the sea in daylight, and various difficulties in reading and writing, especially if the light were bright. "Undoubtedly," he says, "I must always have had a very "weak perception of colour; red I could always tell "in mass, but green I often confused with brown and "certain shades of blue. Also pinks and light blues "are often confused."

## APPENDIX I.

### MISCELLANEOUS CORRESPONDENCE, &c.

1. Letter from the Admiralty.

Admiralty, S.W.
30th August 1910.

Sir,

With reference to your letter of the 25th instant, M. 16,923, enquiring whether statistics can be furnished of mistakes which have been made in the reading of lights or the sighting of objects at sea owing to defective form vision or colour blindness, I am commanded by my Lords Commissioners of the Admiralty to acquaint you, for the information of the Board of Trade, that no record of this nature exists at the Admiralty.

I am, Sir,
Your obedient Servant,
(Signed) W. Graham Greene.

The Secretary,
Board of Trade.

2. Letter and Resolution from the Liverpool Steam Ship Owners' Association.

10, Water Street, Liverpool,
22nd December 1910.

Dear Sir,

With further reference to my letter of the 22nd November, I am directed to place before your committee the following copy of a resolution passed unanimously at a general meeting of this Association held on the 20th instant:—

"After careful enquiry the Liverpool Steam Ship Owners' Association—

"(1) is satisfied that the owners of the types of vessel in which of recent years there has been a great increase in speed are fully alive to the necessity for maintaining a high standard of efficiency in regard to the power of vision of the officers employed on such vessels, and are taking all precautions necessary to secure the observance of such a standard; and

"(2) has failed to discover any instance since 1894 in which the safety of life or property at sea has been imperilled by the defective eyesight of either an officer or a seaman."

The Association is therefore of opinion that the form and colour vision tests, as applied by the Board of Trade since 1894, are adequate, and that it is unnecessary and undesirable to make any changes in such tests.

Yours truly,
(Signed) Norman Hill,
Secretary.

S. G. Tallents, Esq., Secretary,
Sight Tests Committee.

3. Resolution forwarded to the Board of Trade by the Liverpool Local Marine Board.

"That this Board view with alarm the increased stringency of the Board of Trade tests in 'form vision,' and are strongly of opinion that the raised standard of efficiency it is proposed to make compulsory upon all candidates presenting themselves for their first examination for Board of Trade certificates of competency on and after the 1st January 1914 is unnecessary, and in the future, if insisted upon, would lead to injustice and hardship being inflicted upon men at present passing for master or mate under the 'old conditions' of 'form vision'; it is also considered unnecessary as affecting the requirements of the mercantile marine or the safety of the travelling public."

4. Extract from Letter from the Chamber of Shipping of the United Kingdom.

5, Whittington Avenue,
Leadenhall Street, E.C.,
15th November 1910.

Dear Sir,

* * * * *

I am also instructed to inform you that the executive council of this Chamber are of opinion that the eyesight of every boy who intends to become an apprentice to the sea should be carefully tested before he goes to sea, and, likewise, that the sight of all deck officers should be examined periodically during the whole of their seafaring life, inasmuch as in the course of years some men become colour blind who were not so originally.

In this connection, I may state that I am informed by the Orient Steam Navigation Company that that Company require all watchkeeping officers in their service to undergo annual tests both for form and colour vision no less severe than those imposed by the Board of Trade on candidates under examination. These tests are applied by a medical officer specially appointed by the Company for that purpose. The Orient Company also require all A.B.'s to secure Board of Trade eyesight certificates prior to engagement.

I am further informed by the Shaw, Savill, and Albion Company, Limited, that they require that every deck officer on appointment or promotion shall produce a Board of Trade certificate that his sight at the time is good and that he is not defective in colour vision. Every commander and deck officer in their service must possess such a certificate and must renew it from time to time at intervals of not exceeding two years.

I am, Dear Sir,
Yours faithfully,
(Signed) W. H. Cooke,
Secretary.

S. G. Tallents, Esq.,
Secretary, Sight Tests Committee,
Board of Trade, S.W.

5. Resolution Unanimously Agreed to at the Annual Meeting of the Chamber of Shipping of the United Kingdom on 17th March 1911.

"That it is undesirable to increase the severity of the form and colour tests now administered to candidates for officers' certificates."

6. LETTER FROM THE UNION-CASTLE MAIL STEAMSHIP COMPANY, LIMITED.

3 and 4, Fenchurch Street,
London, E.C.
30th December 1910.

SIR,

WE have now given careful consideration to the various questions referred to in your favour of 1st instant, which we acknowledged on the following day, and beg to say that we would have no objection to our Marine Superintendent giving evidence before the Committee if they were desirous of his doing so, and were of opinion that any further questions would thereby be elucidated.

Regarding the points enumerated in your letter, we beg to offer the following observations:—

(1) Apart from the very limited number of deck boys we carry who undergo simple tests of our own for distance vision and colour vision in the colours red, green, blue, yellow and white, no tests other than those of the Board of Trade are imposed upon officers and seamen in our employ.

(2) We have no record of any mistakes in the reading of lights or signals at sea due to colour-blindness or defective form vision.

(3) Regarding the standard of form vision it is difficult for us to summarise the experience of the Company in exact terms, but we think that there is a pretty general agreement that the essential requirement in those referred to is quality of sight, *i.e.*, acuteness of vision or sharp-sightedness in making out distant objects, but that it is difficult to fix an absolute standard for this purpose. A test by letters alone may be too restricted or too severe, and we should think that any test to be effective should also include an examination of the eyes, both separately and together, and the use of lines as well as letters, both in natural and artificial light.

Again, with regard to the question of colour we think the present wool test certainly errs on the side of being too elaborate, and could probably be made simpler by the elimination of a number of delicate shades without impairing its practical efficiency.

Apart from the questions referred to above, we would suggest that careful consideration should be given to the expediency of adding to the present Authority some further representation of the practical sea-going element, either in an executive or consultative capacity.

We are, Sir,
Yours faithfully,
The Union-Castle Mail Steamship
Company, Limited.
(Signed) DONALD CURRIE & Co.
Managers.

S. G. Tallents, Esq., Secretary,
Sight Tests Committee,
Board of Trade,
Whitehall Gardens, S.W.

7. LETTER FROM MESSRS. ISMAY, IMRIE AND COMPANY.

Liverpool,
15th December 1910.

SIR,

WE beg to acknowledge your letter of the 12th instant, and may say that we do not desire to specially nominate a witness to give evidence before your Committee. In reply, however, to the points you raise we beg to state as follows:—

(1) This Company does not apply any tests apart from those of the Board of Trade for the officers and seamen, but we have a regulation that all commanders and officers be examined on appointment in the service, after any serious illness, and every second year.

(2) We have no records of any mistakes having been made in the reading of lights or signals at sea due to colour-blindness or defective form-vision.

(3) Our Marine Superintendent states that the examination at present in force appears to be satisfactory, excepting in the assorting of various shades of wool, which might be substituted by a more practical test of the candidate's ability to distinguish between the white, green, and red lights.

We are, Sir,
Your obedient servants,
For ISMAY, IMRIE & Co.
(ltd.) H.C.

The Secretary,
Sight Tests Committee,
Board of Trade,
Whitehall Gardens, London, S.W.

8. LETTER AND MEMORANDUM FROM THE ORIENT STEAM NAVIGATION COMPANY, LIMITED.

13, Fenchurch Avenue,
London, E.C.
15th December 1910.

SIR,

WITH reference to your letter of 12th instant, I enclose a memorandum giving the views of this Company upon the subjects which fall within the terms of reference of the Sight Tests Committee.

I presume that the information required from Shipping Companies should be essentially practical, and with this end in view, I have interviewed our commanders and officials in order to obtain the result of their observation and experience afloat.

You will observe that while the Company insist on executive officers being examined annually, the commanders are exempted. In some few cases the commanders, owing to age, might be unable to pass the test for *full* normal vision appropriate to younger men, yet having regard to the fact that the relative disability from this cause can in great measure be overcome by wearing glasses, and that the commander invariably has the assistance of the officer of the watch in distinguishing objects or lights, my managers are of the opinion that it is far outweighed by the value of the experience which long service supplies. It would be an intolerable hardship to commanders, and most disadvantageous to the interests of the Mercantile Marine, if they were to be discarded for sight failure, except of a wholly disabling nature. Should a commander suffer from any such grave defect of vision the question of his fitness for command would be dealt with according to the circumstances of each case.

I am, Sir,
Your obedient servant,
(Signed) E. A. VEALE,
Secretary.

S. G. Tallents, Esq.,
Board of Trade,
Whitehall Gardens, S.W.

MEMORANDUM.

(1) As to tests of form-vision or colour-vision, apart from the Board of Trade tests, which you may impose upon the officers or seamen in your employ.

All executive officers and seamen are examined annually by a specially appointed medical officer for form and colour vision. The test employed is practically equivalent to the Board of Trade tests, with differences such as testing each eye separately.

In the case of an officer, if any defect was reported, we should send him to an ophthalmic specialist to be again examined and obtain his report before coming to a decision as to the officer's fitness for our service.



(2) As to any mistakes in the reading of lights or signals at sea of which you have record and which may have been due to colour-blindness or defective form-vision.

(3) As to the standard of form-vision which the experience of your Company leads them to believe necessary in officers and others holding responsible positions at sea.

We have no record of any such mistakes having been made, and our enquiries indicate that a commander would, from motives of self-preservation, immediately report any officer of whose sight he was in any way doubtful.

The Board of Trade test is, in our opinion, quite adequate in all ordinary cases, but should the candidate fail to pass the test his case should be submitted for expert opinion before his livelihood is taken from him by withholding a certificate of competency. In some very few cases perhaps it would be necessary to apply some practical test.

9. LETTER FROM MESSRS. THOS. WILSON, SONS AND COMPANY, LIMITED.

Marine Department, Hull,
30th December 1910.

DEAR SIR,

YOUR favour of 12th instant received.

We do not desire to give evidence before the Committee, or to nominate a witness. In reply to your queries—

1st.—We have discontinued eyesight tests, but send all to the Board of Trade examiner for testing when required.

2nd.—We have no records of wrong reading of lights or signals at sea, due to colour-blindness or defective vision.

3rd.—Consider the present Board of Trade (higher tests) fulfil the necessary requirements.

We would, however, suggest that at Hull, where we have a large expanse of river and long range, all candidates for mates' and masters' certificates be examined at night by the river, under the conditions then existing. At other ports where these conditions do not exist, the candidates be taken afloat in the track of shipping.

Your obedient servants,
For Thos. Wilson, Sons & Co., Ltd.,
(Signed) OSWALD SANDERSON,
Managing Director.

S. G. Tallents, Esq.,
Secretary, Sight Tests Committee,
Board of Trade, Whitehall
Gardens, London, S.W.

10. EXTRACT FROM A LETTER FROM THE CLYDE STEAM SHIP OWNERS' ASSOCIATION.

94, Hope Street, Glasgow,
14th December 1910.

DEAR SIR,

* * * * *

I AM, however, requested to express the hope that when the Committee have completed their investigations, the regulations they propose will not have the effect of limiting the number of officers available for sea service.

I am,
Yours faithfully,
(Signed) WALTER PATTERSON,
Secretary.

The Secretary,
Sight Tests Committee,
Board of Trade, Whitehall Gardens,
London, S.W.

11. LETTER AND ENCLOSURE FROM NORTH OF ENGLAND PROTECTING AND INDEMNITY ASSOCIATION.

Collingwood Buildings,
Newcastle-on-Tyne,
28th December 1910.

SIR,

REFERRING to my respects of the 13th instant, I now beg to inform you that the matter has been considered by my directors who instructed me to communicate with a member of our Board who has had practical sea experience, putting the contents of your letter before him. He now replies as per enclosed copy of letter to which I beg reference, and shall be glad to know that you will treat the contents of same as a memorandum from this Association to your Committee.

I am, Sir,
Your obedient humble servant,
p.p. Ralph Carr, Manager.
(Signed) F. MILLER,
Local Secretary.

The Secretary,
Board of Trade,
Whitehall Gardens,
London.

30, West Sunniside, Sunderland,
22nd December 1910.

DEAR MR. CARR,

I AM in receipt of your letter enclosing letter addressed to you by the Secretary of the above-named Committee.

I would gladly give any evidence on this subject in my power, but do not care to bind myself to attend on dates which may prove inconvenient later.

I think it will be sufficient if your Association sends a memorandum to the Committee as indicated in the Secretary's letter. The degree of colour blindness which, in my opinion, makes a responsible officer incompetent is when he confuses any shade of green or red with a white light, and my feeling is that this test should be made in a dark room to be as near as possible to sea conditions. There is no doubt that very pale green lights are mistaken for white lights by men with defective colour sight, also white lights of an orange tint are mistaken for red lights. I would test on these points.

Another defect I have met with is that a light many miles away is imagined to be close to. This is fairly common, but perhaps not so dangerous as it is inconvenient. The officer thus affected will shift his ship's course to keep out of the way of ships which would not pass near him at all in any case. When this defect of distance sight is combined with faulty discrimination of colours great confusion results.

Of course, there are varying degrees of these defects.

Wishing you the compliments of the season.

Yours very truly,
(Signed) ARTHUR RITSON.

Ralph Carr, Esq.,
Newcastle-on-Tyne.

12. LETTER FROM MESSRS. ALFRED HOLT & Co.

India Buildings,
Water Street, Liverpool,
13th October 1911.

SIR,

IN reply to your letter of the 11th instant, our Medical Superintendent informs us that in the past five years about 3 per cent. of the applicants for posts as officers in our line have been rejected on account of defective vision.

As regards the nature of the examination, he states—

"The candidate standing opposite at an interval of 15 feet is required to count the number of black dots on a white card with shaded electric light. These dots have a diameter of $\frac{1}{20}$th inch, $\frac{1}{30}$th inch, and $\frac{1}{40}$th inch. An ordinary normal-sighted man has no difficulty in seeing the $\frac{1}{20}$th inch at 15 feet, and should he have acute vision, the $\frac{1}{30}$th inch and $\frac{1}{40}$th inch; but for these latter a reasonable shortening of the distance is allowed. Each eye is also tested with $\frac{1}{20}$th inch.

"Snellen's letter type is used in doubtful cases in addition, and the officer should be able to read V = 4.5. M., or at any rate, V = 6. M. (that is, the letters marked for 20 feet should be read at 15 feet without mistake)."

With reference to your question as to the annual re-examination of officers, his view is that it is reasonable at more advanced ages to apply an outdoor test rather than to insist rigidly on those described above. Should, therefore, any notable defect be discovered, the man would be given a practical test, such as being

taken to the pierhead, or on to a ferry-boat, and requested to pick our various objects on the river and its banks, and to answer questions concerning them.

We are, yours truly,
(Signed) ALFRED HOLT & Co.

T. Lodge, Esq., Secretary,
Sight Tests Committee,
Board of Trade, London.

13. REPORT BY DR. MELVILLE-DAVISON, MEDICAL INSPECTOR TO THE BOOTH STEAMSHIP COMPANY, LIMITED.

Tower Buildings, Liverpool.
27th October 1911.

DEAR SIRS,

THE following is a table of the captains', officers', and crews' eyesight tests during the past four years:—

*Captains.*

These are examined every three years—

| | | | |
|---|---|---|---|
| Tested | - | - | 35 |
| Rejected | - | - | 0 |
| Right eye | - | - | 7 with 60 per cent. vision. |
| Left eye | - | - | 8 „ 40 „ „ |

Three captains under normal with both eyes had 60 per cent. right, 40 per cent. left; of these, two were under 50 years of age.

(*a*) *Officers (Candidates for Entrance).*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Tested | - | - | - | - | - | - | - | 51 |
| Rejected | - | - | - | - | - | - | - | 3 |

Two had only 40 per cent. normal vision in both eyes.

One had only 20 per cent. normal vision in both eyes.

(*b*) *Officers (Permanent Staff).*

These are examined every two years.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Tested | - | - | - | - | - | - | - | 160 |
| Rejected | - | - | - | - | - | - | - | 0 |

Of these two only had a depreciation of normal vision to any extent.

Both these officers only had 40 per cent. of normal vision.

On re-testing, however, with moving objects on the river and in the docks they proved quite satisfactory.

There was no rejection for colour blindness in any captain or officer.

All were tested for double vision with negative results.

*Crews (A.B.'s, O.S.'s, and Boys).*

All are tested on joining the company both for form vision and colour blindness.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Tested | - | - | - | - | - | - | - | 943 |
| Rejected | - | - | - | - | - | - | - | 59 |

The causes were—

| | | | | | |
|---|---|---|---|---|---|
| Colour blindness | - | - | - | - | 6 (2 boys). |

Tobacco and alcohol accounted for the majority of the others. No doubt on re-examination at a future date, when the effects of both of these stimulants had passed off, it would have been found that their vision approximated to the normal.

My experience, therefore, shows the following points:—

1. Age has little or no effect on form vision or visual acuity, and there is no depreciation consequent on advancing years.
2. The using of the sextant with the consequent strain of reading the scale and the exposure to the strong concentrated rays of the sun cause the eye used to depreciate to the extent sometimes of 15 per cent.
3. Colour blindness occurred in only ½ per cent. of the total examinations.
4. Rejections for form vision were 5 per cent. of men examined.
5. There were no rejections amongst those who having passed the original examination were re-examined at a later date as a matter of routine.

*Tests used.*

I am enclosing test dots used.*

The distance for officers and men with these is 12 feet, each eye tested separately. There is, however, a higher standard which is always expected, viz., 16 feet.

This higher standard was passed by all captains, officers, and boys. It is, however, not expected from A.B.'s.

In addition to the dots, Snellen's types of the number, size, and pattern in use at the Board of Trade offices were used. It was found that men who had passed the dot test had no difficulty in passing the Snellen type test. Where they were tested with the types first it was also found that there was never any difficulty with the dots.

I am,
Yours truly,
(Signed) WM. MELVILLE-DAVISON.

The Board of Trade,
Sight Tests Committee.

14. LETTER FROM THE LONDON AND NORTH-WESTERN RAILWAY COMPANY.

General Manager's Office,
Euston Station, London, N.W.
22nd February 1911.

DEAR SIR,

WITH reference to your letter of the 27th July last, addressed to the Railway Companies' Association, asking if the members could supply evidence as to—

(1) Mistakes in the reading of lights on the railway which may have been due to defective form or colour vision.

(2) Any cases in which a man suffering from defective vision without making a definite mistake has yet reported that he found difficulty in reading signals by day or night or alternatively has been able to prove that in practice he found no such difficulty.

As it is felt that the subject is one which the Companies individually should reply upon, I have to say so far as this Company is concerned, that as regards enquiry—

No. 1. There is no record of any mistake being made in reading signals, either by day or night, having been attributed to defective vision, or to colour blindness. Drivers, firemen, and cleaners have their sight examined once a year; the examination is carried out in the first place by the foreman by means of eyesight colour cards, and if there is any defect the men are then sent to the Company's doctor at Crewe, who examines them more thoroughly by means of the wool test, and by practical tests which include different coloured flags, coloured lamps in a dark room, and actual working signals in the open.

as to—

No. 2. Only one case can be recollected of a man voluntarily complaining of his eyesight failing. The particulars are as follows:—

A fireman employed upon the main line express working at Crewe, reported on 10th December 1909, that his right eye was failing, and that he had difficulty in seeing signals. He was at once sent to the Company's doctor for examination, who reported that he was not fit for the duty of fireman, and he was reduced from firing, and found employment on the shed. In October last year he asked to be allowed to submit himself to the doctor for re-examination, as his eye was better. He was able to pass his foreman's examination in counting the dots by the card tests and was then examined by the Company's doctor, who, on this occasion, found that his vision was all right, and he was passed for main line work, and again resumed work as fireman on 15th October 1910.

Yours faithfully,
For FRANK REE,
(ltd.) F. G.

The Secretary,
Sight Tests Committee,
Board of Trade,
Whitehall Gardens, London, S.W.

* Not printed.



15. LETTER FROM THE GREAT CENTRAL RAILWAY COMPANY.

General Manager's Office,
Marylebone Station,
London, N.W.
27th February 1911.

DEAR SIR,

REFERRING to your letter of the 27th July last, addressed to the Railway Companies' Association, so far as this Company is concerned it is our practice to test the staff by means of Holmgren Wools, and we have found this system quite satisfactory.

We have not up to the present had a case of a man passing a signal at "danger" traceable to defective colour-vision, and very great care is exercised to guard against such an occurrence.

Three cases have arisen since 1892 where men have voluntarily come forward and admitted that their sight was failing, but these were instances of defective distance-vision, and in no way connected with colour-blindness. There have also been cases of men who at one time had passed the colour test failing later on as a result of excessive smoking, and who have recovered their normal sight on abstention from this habit.

I would remark, however, that these are most exceptional cases, and as a general rule there has been no doubt that the staff who have failed to pass the test have been proved to have defective colour faculty.

Yours faithfully,
(Signed) SAM FAY.

S. G. Tallents, Esq.,
Board of Trade.
Whitehall Gardens, S.W.

16. LETTER FROM THE GREAT EASTERN RAILWAY COMPANY.

General Manager's Office,
Liverpool Street Station,
London, E.C.,
March 15th, 1911.

DEAR SIR,

WITH reference to your letter of the 27th July last, addressed to the Secretary of the Railway Companies' Association, respecting instances (under certain conditions) of mistakes being made in the reading of lights on the railway, or difficulty experienced in reading signals by day or by night, I beg to say that we have no record of any such cases having occurred on this railway.

I am, Sir,
Your obedient Servant,
(Signed) W. H. HYDE,
General Manager.

S. G. Tallents, Esq.,
Secretary to the Sight Tests Committee,
Board of Trade, S.W.

# APPENDIX J.

## RESULTS OF LABORATORY EXAMINATIONS.

All the observers and nine of the ten persons who acted as recorders at Shoeburyness were examined as to their colour vision and form vision, and the results of these examinations are as follows:—

### I.—OBSERVERS.

*Observer No.* 1 was found to be green deficient, and from the luminosity measurements it is calculated that he only possesses 30 per cent. of the normal green sensation. He has a neutral point, matching a green (510 $\mu\mu$) with a white, and sometimes called this green white, sometimes white.

With small spots of coloured light he made the mistakes shown in the following table:—

| Wave-length of Light shown, $\mu\mu$. | Colour of Light shown. | Called. |
|---|---|---|
| 656 | Red | White. |
| 610 | Red | Green. |
| 585 | Yellow | Red. |
| 556 | Green | White. |
| 560 | Green | Red. |
| 525 | Bluish-Green | Red. |
| 474 | Blue | Green. |

*Form vision*:—
Right eye normal ($^5/_5$).
Left eye three-quarters of normal ($^5/_{6\cdot7}$).

*Observer No.* 2 was found to be red deficient, and from the luminosity measurements it is calculated that he only possesses 10 per cent. of the normal red sensation. He has a neutral point, and calls a part of the spectrum in the green white. With small spots of coloured light he made the mistakes shown in the following table:—

| Wave-length of Light shown, $\mu\mu$. | Colour of Light shown. | Called. |
|---|---|---|
| 660 | Deep Red | Could not see. |
| 600 | Yellow | Red. |
| 572 | Yellow-Green | Red. |
| 570 | Yellow-Green | White. |
| 559 | Green | Red. |

*Form vision*:—
Right eye normal ($^5/_5$).
Left eye normal ($^5/_5$).

*Observer No.* 3 was found to be partly green deficient, and from the luminosity measurements it is calculated that he only possesses 60 per cent. of the normal green sensation. He said that a portion of the spectrum in the green was a neutral colour.

With small spots of coloured light he made the following mistakes:—

| Wave-length of Light shown, $\mu\mu$. | Colour of Light shown. | Called. |
|---|---|---|
| 670 | Deep Red | Green. |
| 640 | Red | Green. |
| 612 | Red | Green (on coming near called this Red). |
| 590 | Yellow | Green. |
| 585 | Greenish-Yellow. | Red. |
| 557 | Green | Red. |

*Form vision* :—
Right eye normal (5/5).
Left eye practically normal.

*Observer No.* 4 was found to be slightly red deficient, and from the luminosity measurements it is calculated that he only possesses 85 per cent. of the normal red sensation. The only mistakes he made were that he failed to see a very deep red (690 $\mu\mu$), he said a green (558 $\mu\mu$) was white with a tinge of green, and that a yellow (580 $\mu\mu$) was a white with a tinge of red.

*Form vision* :—
Right eye normal (5/5).
Left eye blind from wound in 1907.

*Observer No.* 5 was found to be red deficient, and from the luminosity measurements it is calculated that he only possesses 5 per cent. of the normal red sensation. He has a neutral point at 500 $\mu\mu$, at which point he matches the green with a white. He entirely failed to see a deep red light. A bright red mixed with a little white he called green. With the small spots of coloured light he made the following mistakes:—

| Wave-length of Light shown. $\mu\mu$. | Colour of Light shown. | Called. |
|---|---|---|
| 630 | Red | Could hardly see and called it White. |
| 593 | Orange-Yellow | White. |
| 590 | Orange-Yellow | Red. |
| 565 | Green | White. |
| 515 | Bluish-Green | White. |
| 500 | Bluish-Green | White. |

*Form vision* :—
Right eye: normal (5/5) refraction very slightly hypermetropic. Eye healthy.
Left eye: half normal (5/10). Slight myopic astigmatism. Vision can be raised to (5/5) by a lens. Eye healthy.

*Observer No.* 6 was found to be red deficient and from the luminosity measurements it is calculated that he only possesses 5 per cent. of the normal red sensation. He could not see a deep red light and said a blue green was nearly white.

With the spots of coloured light he made the following mistakes:—

| Wave-length of Light shown. $\mu\mu$. | Colour of Light shown. | Called. |
|---|---|---|
| 665 | Deep Red | Could hardly see and thought it was a faint White. |
| 620 | Red | Green. |
| 590 | Yellow | Green. |
| 570 | Yellow-Green | White. |
| 540 | Green | White. |
| 510 | Blue-Green | Doubtful about colour, but thought it might be Green. |

*Form vision* :—
Right eye normal (5/5).
Left eye normal (5/5).
Both eyes healthy with emmetropic or very slight hypermetropic refraction.

*Observer No.* 7 has normal colour vision and when near would always tell the colour. With small spots of coloured light he called a bright red (660 and 630 $\mu\mu$) green, but when fitted with spectacles was able to correct himself at once. His luminosity showed that he possesses the normal colour sensations.

*Form vision* :—
Right eye one-fifth normal (5/20). Myopic and slightly astigmatic.
Left eye a quarter to a fifth normal (5/20–5/30) rather less myopia than for right eye, astigmatism similar to right.

Vision for each eye raised to normal (5/5) by proper glasses. Eyes healthy.

*Observer No.* 8 has normal colour vision as tested both by the luminosity method and with the spots of light. With these latter his answers were always correct and given without hesitation.

*Form vision* :—
Right eye practically normal (5/5).
Left eye practically normal (5/5).
Has slight hypermetropic astigmatism. Eyes healthy.

*Observer No.* 9 has normal colour vision as shown by his luminosity curve, and by testing with large patches of colour. With small spots of colour, however, he made the following mistakes:—

| Wave-length of Light shown. $\mu\mu$. | Colour of Light shown. | Called. |
|---|---|---|
| 593 | Orange-Yellow | Red. |
| 572 | Yellow-Green | White. |
| 470 | Dark Blue | White. |

*Form vision* :—
Each eye between a fifth normal and a quarter normal (5/25 and 5/20). Considerable astigmatism. Exact amount and character (whether all hypermetropic or mixed) cannot be determined without using drops to suspend accommodation. Sight not much improved by the approximately correct glasses. Eyes healthy. Both eyes together he has half normal (5/10).

*Observer No.* 10 was found to be green deficient, and from luminosity measurements and colour equations it is calculated that he only possesses 45 per cent. of the normal green sensation.

With the new lantern he made the following mistakes:—
Shown white he called it green.
Shown white he called it red.
Shown red he called it green.

*Form vision* :—
Right eye normal (6/6)
Left eye normal (6/6) } Emmetropic.

*Observer No.* 11 was found to be slightly green deficient, and from luminosity measurements and colour equations it is calculated that he only possesses 70 per cent. of the normal green sensation.

With the new lantern he made the following mistakes:—
Shown white he called it green.
Shown white he called it red.

*Form vision* :—
Right eye normal (6/6)
Left eye normal (6/6) } Emmetropic or only a trace of hypermetropia.

*Observer No.* 12 was found to be very slightly red deficient, and from the luminosity measurements and colour equations it is calculated that he only possesses 80 per cent. of the normal red sensation.

With the new lantern he made no mistakes.

*Form vision* :—
Right eye normal (6/6)
Left eye normal (6/6) } With 1·25 D of manifest hyermetropia in each.

*Observer No.* 13 has normal colour vision as tested by the luminosity measurements and colour equations. He also made no mistakes with large patches of colour. When tested with the small apertures of the new lantern he made the following mistakes:—
Shown green he called it white.
Shown white he called it red.
Shown green he did not notice the light.
Shown red he did not notice the light.

*Form vision* :—
Right eye 6/24. Considerable myopic astigmatism:—
$\left(\frac{-2 \text{ sph.}}{-0{\cdot}5 \text{ cyl. } 30° \text{ down and in}} = 6/6\right)$.
Left eye 6/18. Slight myopic astigmatism:—
$\left(\frac{-0{\cdot}5 \text{ sph.}}{-0{\cdot}25 \text{ cyl. } 30° \text{ down and out}} = 6/6\right)$.



*Observer No.* 14 has normal colour vision as tested by the luminosity measurements and colour equations. He made no mistakes with large patches of colour. Tested with the small apertures of the new lantern he made two mistakes; once he called white green, and once white red.

*Form vision* :—
Right eye 6/18 [− 1·5 cyl. 80° down and in = 6/6].
Left eye 6/5 [− 0·5 cyl. ↓ vert. = 6/6].

*Observer No.* 15 was found to be very slightly red deficient, and from luminosity measurements and colour equations it is calculated that he has 90 per cent. of the normal red sensation.

With the new lantern he made three mistakes:—
Shown white he called it red (twice).
Shown red he called it white.

*Form vision* :—
Right eye normal 6/6
Left eye normal 6/6 } Emmetropic.

*Observer No.* 16 has normal colour vision as tested by the luminosity measurements and colour equations. He made no mistakes with large patches of colour. When tested with the small apertures of the new lantern he made the following mistakes:—
Shown white he called it green.
Shown red he called it white.

*Form vision* :—
Right eye 6/12 (most) (+ 0·5 dcyl. → = 6/6).
Left eye 6/12 (badly) $\left(\frac{-0{\cdot}25 \text{ dsph.}}{-0{\cdot}75 \text{ dcyl. } \swarrow 80°} = 6/6\right)$.

*Observer No.* 17 was found to be partly green deficient, and from the luminosity measurements and colour equations it is calculated that he has only 55 per cent. of the normal green sensation. With the new lantern he made the following mistakes:—
Shown red he called it white.
Shown white he called it green.

*Form vision* :—
Right eye less than 6/60 $\left[\frac{-2{\cdot}75 \text{ sph.}}{-1 \text{ cyl. } 80° \text{ down and in}} = 6/6\right]$.
Left eye 6/9 (barely) [− 0·5 sph. = 6/5].

*Observer No.* 18 was found to be slightly red deficient, and from the luminosity measurements and colour equations it is calculated that he has 80 per cent. of the normal red sensation. He made no mistakes with the new lantern when using his spectacles.

*Form vision* :—
Right eye less than 6/60 (−3·25 sph. = 6/6).
Left eye less than 6/60 (− 3·25 sph. = 6/6).
With his spectacles he had normal vision 6/6 in each eye.

*Observer No.* 19 was found to be slightly red deficient, and from the luminosity measurements and colour equations it is calculated that he has 85 per cent. of the normal red sensation. With the new lantern, using his spectacles, he made the following mistakes:—
Shown green he called it white.
Shown white he called it red.

*Form vision* :—
Right eye less than 6/60
$\left[\text{own glass } \frac{-5 \text{ sph.}}{-0{\cdot}75 \text{ cyl. } \searrow 60° \text{ down and in}} = 6/6\right]$
Left eye less than 6/60
$\left[\text{own glass } \frac{-4 \text{ sph.}}{-3 \text{ cyl. } \swarrow 45° \text{ down and in}} = 6/6\right]$.

*Observer No.* 20 was found to be very slightly red deficient, and from the luminosity measurements it is calculated that he has 90 per cent. of the normal red sensation. When using his spectacles he made no mistakes with the new lantern.

*Form vision* :—
Right eye 6/60 [− 1·75 sph. = 6/6].
Left eye 6/12 badly [− 0·75 sph. = 6/6].
With his glasses—
Right eye (− 2 sph.) = 6/9 badly.
Left eye (− 1 sph.) = 6/9 all.

## II.—Recorders.

*Recorder No.* 1 has normal colour vision. With the small apertures of the new lantern he called white red three times.

*Form vision* :—
Right eye normal (5/5)
Left eye normal (5/5) } Refraction slightly hypermetropic.

*Recorder No.* 2 has normal colour vision. He made no mistakes with the new lantern.

*Form vision* :—
Right eye = 5/15. Refraction hypermetropic.
Left eye = 5/5. Refraction slightly hypermetropic.

*Recorder No.* 3 has normal colour vision. He made no mistakes with the new lantern.

*Form vision* :—
Right eye = 5/5
Left eye = 5/5 } Emmetropic or with slight hypermetropic refraction.

*Recorder No.* 4 has normal colour vision. He made no mistakes with the new lantern.

*Form vision* :—
Right eye = 5/5
Left eye = 5/5 } Emmetropic.

*Recorder No.* 5 has normal colour vision. He made no mistakes with the new lantern.

*Form vision* :—
Right eye = 5/5
Left eye = 5/5 } Refraction slightly hypermetropic.

*Recorder No.* 6 has normal colour vision. He made no mistakes with the new lantern.

*Form vision* :—
Right eye = 5/5 (4 or 5 mistakes)
Left eye = 5/5 (4 or 5 mistakes) } with − 0·25 = 5/5 well.

*Recorder No.* 7 was found to be partly green deficient. With the small apertures of the new lantern he called white both green and red; he called red both green and white, and green both white and red.

*Form vision* :—
Right eye = 5/5. Refraction very slightly myopic.
Left eye = 5/5. Emmetropic.

*Recorder No.* 8 was found to be partly green deficient. With the small apertures of the new lantern he called white both green and red, he called red both green and white, and he called green red.

*Form vision* :—
Right eye = 5/5 (4 mistakes)
Left eye = 5/5 (about half) 5/6-7 (well) } Refraction slightly hypermetropic.

*Recorder No.* 10 has normal colour vision. He made no mistakes with the new lantern.

*Form vision* :—
Right eye = 5/5
Left eye = 5/5 } Emmetropic.

# APPENDIX K.

## Results of Experiments conducted at Shoeburyness, 1911.

### First Series, January 31st to February 11th, 1911.

Note.—In the following tables the capital letters denote the lights shown, the small letters the names given to those lights by the observers. As explained in the report (*see* page 22), three lamps were used—an English oil lamp, an English electric lamp, and a German oil lamp. These are distinguished by figures, thus: G 1 means that the green light was shown on the English oil lamp.

Except on the fifth night, February 4th, the seaward and landward lamps were each 20 feet distant from the middle lamp. [On that date the distance between the seaward and middle lamp was reduced to 10 feet.]

### FIRST NIGHT—JANUARY 31st.

The weather throughout was fine and clear.

#### Observer No. 1.

Distance 3,000 yards.

| Observation. | Lights shown. | Report. |
|---|---|---|
| 1 | W 1 W 2 W 3 | w w g |
| 2 | G 1 R 2 W 3 | r w |
| 3 | R 1 W 2 G 3 | w |
| 4 | R 1 G 2 G 3 | not seen. |
| 5 | G 1 – R 3 | r |
| 6 | G 1 – W 3 | w |
| 7 | R 1 – R 3 | correct. |
| 8 | W 1 – R 3 | g w |
| 9 | G 1 W 2 R 3 | g w w |

Distance, 2,000 yards.

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | g w r |
| 2 | W 1 – R 3 | r r |
| 3 | G 1 – R 3 | } correct. |
| 4 | R 1 – R 3 | |
| 5 | G 1 W 2 R 3 | |
| 6 | W 1 R 2 G 3 | g r g |
| 7 | R 1 W 2 G 3 | } correct. |
| 8 | G 1 – G 3 | |
| 9 | R 1 G 2 G 3 | |
| 10 | G 1 R 2 W 3 | g r r |
| 11 | G 1 – W 3 | r w |

Distance, 1,000 yards.

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | } correct. |
| 2 | G 1 G 2 W 3 | |
| 3 | R 1 – R 3 | |
| 4 | W 1 – G 3 | |
| 5 | W 1 G 2 G 3 | w g g* |
| 6 | G 1 R 2 W 3 | g r r |
| 7 | – – G 3 | correct. |
| 8 | – – W 3 | r |
| 9 | – W 2 G 3 | } correct. |
| 10 | – – W 3 | |
| 11 | – – R 3 | |

* Hesitated over the white.

#### Observer No. 2.

Distance, 3,000 yards.

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | r r r |
| 2 | G 1 R 2 W 3 | g r g |
| 3 | R 1 W 2 G 3 | g w g |
| 4 | R 1 G 2 G 3 | g r g |
| 5 | G 1 – R 3 | g w |
| 6 | G 1 – W 3 | g r |
| 7 | R 1 – R 3 | r g |
| 8 | W 1 – R 3 | r r |
| 9 | G 1 W 2 R 3 | r w r |

Distance, 2,000 yards.

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | r w r |
| 2 | W 1 – R 3 | g r |
| 3 | G 1 – R 3 | } correct. |
| 4 | R 1 – R 3 | |
| 5 | G 1 W 2 R 3 | |
| 6 | W 1 R 2 G 3 | g r g |
| 7 | R 1 W 2 G 3 | g w r |
| 8 | G 1 – G 3 | r r |
| 9 | R 1 G 2 G 3 | r g r |
| 10 | G 1 R 2 W 3 | g r r |
| 11 | G 1 – W 3 | r w |

Distance, 1,000 yards.

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | r w g |
| 2 | G 1 G 2 W 3 | g g r |
| 3 | R 1 – R 3 | correct. |
| 4 | W 1 – G 3 | r g |
| 5 | W 1 G 2 G 3 | r w r |
| 6 | G 1 R 2 W 3 | } correct. |
| 7 | – – G 3 | |
| 8 | – – W 3 | r |
| 9 | – W 2 G 3 | correct. |
| 10 | – – W 3 | r |
| 11 | – – R 3 | correct. |

#### Observer No. 3.

Distance, 3,000 yards.

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | g w r |
| 2 | R 1 W 2 G 3 | correct. |
| 3 | W 1 R 2 G 3 | g r g |
| 4 | G 1 – W 3 | g r |
| 5 | R 1 – G 3 | } correct. |
| 6 | G 1 W 2 R 3 | |
| 7 | G 1 – G 3 | |
| 8 | G 1 – R 3 | |
| 9 | G 1 – R 3 | |
| 10 | R 1 G 2 G 3 | |
| 11 | G 1 R 2 W 3 | correct.* |

* At second attempt.

Distance, 2,000 yards.

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | g w r |
| 2 | R 1 – R 3 | } correct. |
| 3 | R 1 W 2 G 3 | |
| 4 | R 1 G 2 G 3 | |
| 5 | G 1 – R 3 | |
| 6 | G 1 W 2 R 3 | |
| 7 | G 1 – W 3 | |
| 8 | G 1 R 2 W 3 | g r g |
| 9 | G 1 – G 3 | correct. |
| 10 | W 1 R 2 G 3 | g r g |
| 11 | W 1 – R 3 | g r |

Distance, 1,000 yards.

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | w w r |
| 2 | G 1 R 2 W 3 | g r g |
| 3 | R 1 W 2 G 3 | } correct. |
| 4 | R 1 G 2 G 3 | |
| 5 | W 1 R 2 G 3 | |
| 6 | G 1 – R 3 | |
| 7 | G 1 – W 3 | |
| 8 | R 1 – R 3 | |
| 9 | W 1 – R 3 | |
| 10 | G 1 – G 3 | |
| 11 | G 1 W 2 R 3 | |



#### Observer No. 4.

Distance, 3,000 yards.

| Observation. | Lights shown. | Report. |
|---|---|---|
| 1 | W 1 W 2 W 3 | g w w |
| 2 | R 1 W 2 G 3 | correct. |
| 3 | W 1 R 2 G 3 | g r g |
| 4 | G 1 – W 3 | } correct. |
| 5 | R 1 – G 3 | |
| 6 | G 1 W 2 R 3 | |
| 7 | G 1 – G 3 | |
| 8 | G 1 – R 3 | |
| 9 | G 1 – R 3 | |
| 10 | R 1 G 2 G 3 | |
| 11 | G 1 R 2 W 3 | |

Distance, 2,000 yards.

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | } correct. |
| 2 | R 1 – R 3 | |
| 3 | R 1 W 2 G 3 | |
| 4 | R 1 G 2 G 3 | |
| 5 | G 1 – R 3 | |
| 6 | G 1 W 2 R 3 | |
| 7 | G 1 – W 3 | |
| 8 | G 1 R 2 W 3 | |
| 9 | G 1 – G 3 | |
| 10 | W 1 R 2 G 3 | r g |
| 11 | W 1 – R 3 | correct. |

Distance, 1,000 yards.

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | } correct. |
| 2 | G 1 R 2 W 3 | |
| 3 | R 1 W 2 G 3 | |
| 4 | R 1 G 2 G 3 | |
| 5 | W 1 R 2 G 3 | |
| 6 | G 1 – R 3 | |
| 7 | G 1 – W 3 | |
| 8 | R 1 – R 3 | |
| 9 | W 1 – R 3 | |
| 10 | G 1 – G 3 | |
| 11 | G 1 W 2 R 3 | |

#### Observer No. 5.

Distance 3,000 yards.

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | g w w |
| 2 | G 1 – W 3 | r g |
| 3 | G 1 – G 3 | correct. |
| 4 | R 1 G 2 G 3 | w g |
| 5 | W 1 R 2 G 3 | r r g |
| 6 | G 1 W 2 R 3 | } correct. |
| 7 | G 1 – R 3 | |
| 8 | R 1 W 2 G 3 | |
| 9 | W 1 – R 3 | g r |
| 10 | R 1 – R 3 | r |
| 11 | G 1 R 2 W 3 | g r w * |

* Was doubtful as to the green.

Distance 2,000 yards.

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | g w r |
| 2 | G 1 – R 3 | r r |
| 3 | W 1 R 2 G 3 | r r g |
| 4 | R 1 – R 3 | } correct. |
| 5 | G 1 R 2 W 3 | |
| 6 | G 1 – W 3 | |
| 7 | G 1 W 2 R 3 | |
| 8 | W 1 – R 3 | g r |
| 9 | R 1 G 2 G 3 | } correct. |
| 10 | G 1 – G 3 | |
| 11 | R 1 W 2 G 3 | |

Distance 1,000 yards.

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | w w g |
| 2 | R 1 W 2 G 3 | correct. |
| 3 | W 1 R 2 G 3 | g r g |
| 4 | G 1 – W 3 | g g |
| 5 | R 1 – R 3 | correct. |
| 6 | G 1 W 2 R 3 | w w r |
| 7 | G 1 – G 3 | w g |
| 8 | R 1 – R 3 | } correct. |
| 9 | G 1 – R 3 | |
| 10 | R 1 G 2 G 3 | |
| 11 | G 1 R 2 W 3 | |



#### Observer No. 6.

Distance 3,000 yards.

| Observation. | Lights shown. | Report. |
|---|---|---|
| 1 | W 1 W 2 W 3 | r w w |
| 2 | G 1 – W 3 | r g * |
| 3 | G 1 – G 3 | correct. |
| 4 | R 1 G 2 G 3 | † |
| 5 | W 1 R 2 G 3 | r r g |
| 6 | G 1 W 2 R 3 | } correct. |
| 7 | G 1 – R 3 | |
| 8 | R 1 W 2 G 3 | g w r |
| 9 | W 1 – R 3 | r r‡ |
| 10 | R 1 – R 3 | r |
| 11 | G 1 R 2 W 3 | correct. |

* Was doubtful as to the last.
† Could not name these.
‡ Was doubtful as to first.

Distance 2,000 yards.

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | correct. |
| 2 | G 1 – R 3 | * |
| 3 | W 1 R 2 G 3 | g r g |
| 4 | R 1 – R 3 | } correct. |
| 5 | G 1 R 2 W 3 | |
| 6 | G 1 – W 3 | g r |
| 7 | G 1 W 2 R 3 | correct. |
| 8 | W 1 – R 3 | r† |
| 9 | R 1 G 2 G 3 | correct. |
| 10 | G 1 – G 3 | ‡ |
| 11 | R 1 W 2 G 3 | r w w |

* Could not see. † Doubtful. ‡ Uncertain.

Distance 1,000 yards.

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | correct. |
| 2 | R 1 W 2 G 3 | r g g |
| 3 | W 1 R 2 G 3 | correct. |
| 4 | G 1 – W 3 | g g |
| 5 | W 1 – R 3 | correct. |
| 6 | G 1 W 2 R 3 | correct. |
| 7 | G 1 – G 3 | g w |
| 8 | R 1 – R 3 | r w |
| 9 | G 1 – R 3 | } Correct. |
| 10 | R 1 G 2 G 3 | |
| 11 | G 1 R 2 W 3 | g r g |

#### Observer No. 7.

Distance 3,000 yards.

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | g r |
| 2 | G 1 – G 3 | * |
| 3 | G 1 – R 3 | w r |
| 4 | G 1 R 2 W 3 | g r |
| 5 | G 1 – W 3 | w |
| 6 | G 1 W 2 R 3 | g r |
| 7 | R 1 – R 3 | g r |
| 8 | R 1 G 2 G 3 | g w |
| 9 | R 1 W 2 G 3 | w |
| 10 | W 1 – R 3 | * |
| 11 | W 1 R 2 G 3 | r g† |

* Could not say. † Doubtful as to green.

Distance 2,000 yards.

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | w w |
| 2 | W 1 G 2 R 3 | g r |
| 3 | G 1 G 2 G 3 | correct. |
| 4 | R 1 – W 3 | w |
| 5 | G 1 G 2 W 3 | g w |
| 6 | G 1 – G 3 | } correct. |
| 7 | R 1 – W 3 | |
| 8 | R 1 G 2 W 3 | g w |
| 9 | G 1 – W 3 | w |
| 10 | W 1 – G 3 | g g |
| 11 | R 1 W 2 G 3 | w g |

Distance 1,000 yards.

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | } correct. |
| 2 | G 1 – W 3 | |
| 3 | G 1 – G 3 | |
| 4 | R 1 G 2 G 3 | |
| 5 | W 1 R 2 G 3 | |
| 6 | G 1 W 2 R 3 | |
| 7 | G 1 – R 3 | |
| 8 | R 1 W 2 G 3 | |
| 9 | W 1 – R 3 | |
| 10 | R 1 – R 3 | |
| 11 | G 1 R 2 W 3 | |

### Observer No. 8.

Distance 3,000 yards.

| Observation. | Lights shown. | Report. |
|---|---|---|
| 1 | W 1 W 2 W 3 | w w |
| 2 | G 1 – G 3 | g |
| 3 | G 1 – R 3 | r |
| 4 | G 1 R 2 W 3 | r w |
| 5 | G 1 – W 3 | w |
| 6 | G 1 W 2 R 3 | w r |
| 7 | R 1 – R 3 | r |
| 8 | R 1 G 2 G 3 | correct. |
| 9 | R 1 W 2 G 3 | w |
| 10 | W 1 – R 3 | r |
| 11 | W 1 R 2 G 3 | r g |

The recorder could only occasionally detect the seaward light.

Distance 1,000 yards.

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | |
| 2 | G 1 – W 3 | |
| 3 | G 1 – G 3 | |
| 4 | R 1 G 2 G 3 | |
| 5 | W 1 R 2 G 3 | |
| 6 | G 1 W 2 R 3 | correct. |
| 7 | G 1 – R 3 | |
| 8 | R 1 W 2 G 3 | |
| 9 | W 1 – R 3 | |
| 10 | R 1 – R 3 | |
| 11 | G 1 R 2 W 3 | |

### Observer No. 9.

Distance 3,000 yards.

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | w g |
| 2 | W 1 R 2 G 3 | r |
| 3 | W 1 – R 3 | r |
| 4 | R 1 – R 3 | r |
| 5 | R 1 W 2 G 3 | g w |
| 6 | R 1 G 2 G 3 | g g |
| 7 | G 1 R 2 W 3 | r w |
| 8 | G 1 – R 3 | r |
| 9 | G 1 – G 3 | g |
| 10 | G 1 – W 3 | w |
| 11 | G 1 W 2 R 3 | w r |

The recorder could never detect the seaward light.

Distance 2,000 yards.

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | r w r |
| 2 | W 1 G 2 R 3 | r g r |
| 3 | G 1 G 2 G 3 | w g g |
| 4 | R 1 – W 3 | correct. |
| 5 | G 1 G 2 W 3 | w g w |
| 6 | G 1 – G 3 | |
| 7 | R 1 – W 3 | correct. |
| 8 | R 1 G 2 W 3 | |
| 9 | G 1 – W 3 | g r |
| 10 | W 1 – G 3 | r g |
| 11 | R 1 W 2 G 3 | correct. |

Distance 1,000 yards.

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | |
| 2 | G 1 – G 3 | |
| 3 | G 1 – R 3 | |
| 4 | G 1 R 2 W 3 | |
| 5 | G 1 – W 3 | |
| 6 | G 1 W 2 R 3 | correct. |
| 7 | R 1 – R 3 | |
| 8 | R 1 G 2 G 3 | |
| 9 | R 1 W 2 G 3 | |
| 10 | W 1 – R 3 | |
| 11 | W 1 R 2 G 3 | |

## SECOND NIGHT—FEBRUARY 1st.

The weather throughout was very clear and fine.

### Observer No. 1.

Distance 3,000 yards.

| Observation. | Lights shown. | Report. |
|---|---|---|
| 1 | W 2 W 1 W 3 | w r r |
| 2 | G 2 – R 3 | correct. |
| 3 | W 2 R 1 G 3 | |
| 4 | R 2 – R 3 | r r* |
| 5 | G 2 R 1 W 3 | g g r |
| 6 | G 2 – W 3 | g r |
| 7 | G 2 W 1 R 3 | g g r |
| 8 | W 2 – R 3 | w w |
| 9 | R 2 G 1 G 3 | correct. |
| 10 | G 2 – G 3 | |
| 11 | R 2 W 1 G 3 | r g g |

* Doubtful—second attempt.

Distance 2,000 yards.

| | | |
|---|---|---|
| 1 | W 2 W 1 W 3 | r r r |
| 2 | W 2 G 1 R 3 | correct. |
| 3 | G 2 G 1 G 3 | |
| 4 | R 2 – W 3 | r g |
| 5 | G 2 G 1 W 3 | g g r |
| 6 | G 2 – G 3 | g r |
| 7 | R 2 – W 3 | |
| 8 | R 2 G 1 W 3 | correct. |
| 9 | G 2 – W 3 | |
| 10 | W 2 – G 3 | |
| 11 | R 2 W 1 G 3 | |

Distance 2,000 yards (with binoculars).

| | | |
|---|---|---|
| 1 | W 2 W 1 W 3 | |
| 2 | R 2 W 1 G 3 | |
| 3 | R 2 – R 3 | |
| 4 | G 2 – W 3 | |
| 5 | W 2 – R 3 | |
| 6 | G 2 W 1 R 3 | correct. |
| 7 | G 2 – G 3 | |
| 8 | R 2 – R 3 | |
| 9 | G 2 – R 3 | |
| 10 | G 2 R 1 W 3 | |
| 11 | G 2 R 1 W 3 | |

Distance 1,000 yards.

| | | |
|---|---|---|
| 1 | W 2 W 1 W 3 | |
| 2 | G 2 – G 3 | |
| 3 | G 2 – R 3 | |
| 4 | G 2 R 1 W 3 | |
| 5 | G 2 – W 3 | |
| 6 | G 2 W 1 R 3 | correct. |
| 7 | R 2 – R 3 | |
| 8 | R 2 G 1 G 3 | |
| 9 | R 2 W 1 G 3 | |
| 10 | W 2 – R 3 | |
| 11 | W 2 R 1 G 3 | |

### Observer No. 2.

Distance 3,000 yards.

| | | |
|---|---|---|
| 1 | W 2 W 1 W 3 | w r g |
| 2 | G 2 – R 3 | |
| 3 | W 2 R 1 G 3 | correct. |
| 4 | R 2 – R 3 | |
| 5 | G 2 R 1 W 3 | g r g |
| 6 | G 2 – W 3 | g w |
| 7 | G 2 W 1 R 3 | g r w |
| 8 | W 2 – R 3 | w r |
| 9 | R 2 G 1 G 3 | w g g |
| 10 | G 2 – G 3 | g g |
| 11 | R 2 W 1 G 3 | w r g |

Distance 2,000 yards.

| | | |
|---|---|---|
| 1 | W 2 W 1 W 3 | w r g |
| 2 | W 2 G 1 R 3 | |
| 3 | G 2 G 1 G 3 | correct. |
| 4 | R 2 – G 3 | r r |
| 5 | G 2 G 1 W 3 | g r w |
| 6 | G 2 – G 3 | g r |
| 7 | R 2 – W 3 | |
| 8 | R 2 G 1 W 3 | correct. |
| 9 | G 2 – W 3 | |
| 10 | W 2 – G 3 | w r |
| 11 | R 2 W 1 G 3 | r r g |



Distance 2,000 yards (with binoculars).

| Observation. | Lights shown. | Report. |
|---|---|---|
| 1 | W 2 W 1 W 3 | r r r |
| 2 | W 2 R 1 G 3 | |
| 3 | W 2 – R 3 | correct. |
| 4 | R 2 – R 3 | |
| 5 | R 2 W 1 G 3 | r r g |
| 6 | R 2 G 1 G 3 | r r g |
| 7 | G 2 R 1 W 3 | |
| 8 | G 2 – R 3 | |
| 9 | G 2 – G 3 | correct. |
| 10 | G 2 – W 3 | |
| 11 | G 2 W 1 R 3 | g r r |

Distance 1,000 yards.

| | | |
|---|---|---|
| 1 | W 2 W 1 W 3 | g r w |
| 2 | G 2 – G 3 | g w |
| 3 | G 2 – R 3 | |
| 4 | G 2 R 1 W 3 | correct. |
| 5 | G 2 – W 3 | |
| 6 | G 2 W 1 R 3 | g g r |
| 7 | R 2 – R 3 | correct. |
| 8 | R 2 G 1 G 3 | |
| 9 | R 2 W 1 G 3 | r g w |
| 10 | W 2 – R 3 | correct. |
| 11 | W 2 R 1 G 3 | r r g |

### Observer No. 3.

Distance 3,000 yards.

| | | |
|---|---|---|
| 1 | W 2 W 1 W 3 | w g r |
| 2 | G 2 – R 3 | correct. |
| 3 | W 2 R 1 G 3 | w g g* |
| 4 | R 2 – R 3 | correct. |
| 5 | G 2 R 1 W 3 | g g w |
| 6 | G 2 – W 3 | correct. |
| 7 | G 2 W 1 R 3 | g g r |
| 8 | W 2 – R 3 | w r* |
| 9 | R 2 G 1 G 3 | correct. |
| 10 | G 2 – G 3 | |
| 11 | R 2 W 1 G 3 | r g g |

* Second attempt.

Distance 2,000 yards.

| | | |
|---|---|---|
| 1 | W 2 W 1 W 3 | w r w |
| 2 | W 2 G 1 R 3 | correct. |
| 3 | G 2 G 1 G 3 | g g |
| 4 | R 2 – W 3 | correct. |
| 5 | G 2 G 1 W 3 | g r w |
| 6 | G 2 – G 3 | correct. |
| 7 | R 2 – W 3 | r g |
| 8 | R 2 G 1 W 3 | correct. |
| 9 | G 2 – W 3 | g r |
| 10 | W 2 – G 3 | correct. |
| 11 | R 2 W 1 G 3 | r g g |

Distance 2,000 yards (with binoculars).

| | | |
|---|---|---|
| 1 | W 2 W 1 W 3 | w r w |
| 2 | R 2 – R 3 | correct. |
| 3 | R 2 W 1 G 3 | r r g |
| 4 | R 2 G 1 G 3 | r g w |
| 5 | G 2 – R 3 | |
| 6 | G 2 W 1 R 3 | correct. |
| 7 | G 2 – W 3 | g r |
| 8 | G 2 R 1 W 3 | |
| 9 | G 2 – G 3 | correct. |
| 10 | W 2 R 1 G 3 | |
| 11 | W 2 – R 3 | |

Distance 1,000 yards.

| | | |
|---|---|---|
| 1 | W 2 W 1 W 3 | r r w |
| 2 | G 2 – G 3 | |
| 3 | G 2 – R 3 | |
| 4 | G 2 R 1 W 3 | correct. |
| 5 | G 2 – W 3 | |
| 6 | G 2 W 1 R 3 | g g r |
| 7 | R 2 – R 3 | r r* |
| 8 | R 2 G 1 G 3 | r g w |
| 9 | R 2 W 1 G 3 | r w w |
| 10 | W 2 – R 3 | correct. |
| 11 | W 2 R 1 G 3 | w r w |

* Second attempt.

### Observer No. 4.

Distance 3,000 yards.

| Observation. | Lights shown. | Report. |
|---|---|---|
| 1 | W 2 W 1 W 3 | |
| 2 | G 2 R 1 W 3 | |
| 3 | R 2 W 1 G 3 | |
| 4 | R 2 G 1 G 3 | |
| 5 | W 2 R 1 G 3 | |
| 6 | G 2 – R 3 | correct. |
| 7 | G 2 – W 3 | |
| 8 | R 2 – R 3 | |
| 9 | W 2 – R 3 | |
| 10 | G 2 – G 3 | |
| 11 | G 2 W 1 R 3 | |

Distance 2,000 yards.

| | | |
|---|---|---|
| 1 | W 2 W 1 W 3 | |
| 2 | R 2 W 1 G 3 | |
| 3 | W 2 R 1 G 3 | |
| 4 | G 2 – W 3 | |
| 5 | W 2 – R 3 | |
| 6 | G 2 W 1 R 3 | correct. |
| 7 | G 2 – G 3 | |
| 8 | R 2 – R 3 | |
| 9 | G 2 – R 3 | |
| 10 | R 2 G 1 G 3 | |
| 11 | G 2 R 1 W 3 | |

Distance 2,000 yards (with prismatic binoculars).

| | | |
|---|---|---|
| 1 | W 2 W 1 W 3 | |
| 2 | W 2 – R 3 | |
| 3 | G 2 – R 3 | correct. |
| 4 | R 2 – R 3 | |
| 5 | G 2 W 1 R 3 | |
| 6 | W 2 R 1 G 3 | w r w |
| 7 | R 2 W 1 G 3 | |
| 8 | G 2 – G 3 | |
| 9 | R 2 G 1 G 3 | correct. |
| 10 | G 2 R 1 W 3 | |
| 11 | G 2 – W 3 | |

Distance 1,000 yards.

| | | |
|---|---|---|
| 1 | W 2 W 1 W 3 | |
| 2 | G 2 – W 3 | |
| 3 | G 2 – G 3 | |
| 4 | R 2 G 1 G 3 | |
| 5 | W 2 R 1 G 3 | |
| 6 | G 2 W 1 R 3 | correct. |
| 7 | G 2 – R 3 | |
| 8 | R 2 W 1 G 3 | |
| 9 | W 2 – R 3 | |
| 10 | R 2 – R 3 | |
| 11 | G 2 R 1 W 3 | |

### Observer No. 5.

Distance 3,000 yards.

| | | |
|---|---|---|
| 1 | W 2 W 1 W 3 | w r g |
| 2 | G 2 R 1 W 3 | correct. |
| 3 | R 2 W 1 G 3 | r g g |
| 4 | R 2 G 1 G 3 | r r g |
| 5 | W 2 R 1 G 3 | |
| 6 | G 2 – R 3 | |
| 7 | G 2 – W 3 | correct. |
| 8 | R 2 – R 3 | |
| 9 | W 2 – R 3 | |
| 10 | G 2 – G 3 | w g |
| 11 | G 2 W 1 R 3 | g r r |

Distance 2,000 yards.

| | | |
|---|---|---|
| 1 | W 2 W 1 W 3 | w g g |
| 2 | R 2 – G 3 | |
| 3 | W 2 – G 3 | |
| 4 | G 2 – W 3 | |
| 5 | W 2 – R 3 | |
| 6 | G 2 – R 3 | correct. |
| 7 | G 2 – G 3 | |
| 8 | R 2 – R 3 | |
| 9 | G 2 – R 3 | |
| 10 | R 2 – G 3 | w g |
| 11 | G 2 – W 3 | correct. |

Distance 2,000 yards (with prismatic binoculars).

| Observation. | Lights shown. | | | Report. |
|---|---|---|---|---|
| 1 | W 2 | W 1 | W 3 | w r g |
| 2 | W 2 | – | R 3 | g r |
| 3 | G 2 | – | R 3 | correct. |
| 4 | R 2 | – | R 3 | correct. |
| 5 | G 2 | W 1 | R 3 | g r r |
| 6 | W 2 | R 1 | G 3 | correct. |
| 7 | R 2 | W 1 | G 3 | r g g |
| 8 | G 2 | – | G 3 | correct. |
| 9 | R 2 | G 1 | G 3 | r w g |
| 10 | G 2 | R 1 | W 3 | correct. |
| 11 | G 2 | – | W 3 | correct. |

Distance 1,000 yards.

| | | | | |
|---|---|---|---|---|
| 1 | W 2 | W 1 | W 3 | w w w* |
| 2 | G 2 | – | W 3 | correct. |
| 3 | G 2 | – | G 3 | correct. |
| 4 | R 2 | G 1 | G 3 | r g w |
| 5 | W 2 | R 1 | G 3 | correct. |
| 6 | G 2 | W 1 | R 3 | g g r |
| 7 | G 2 | – | R 3 | correct. |
| 8 | R 2 | W 1 | G 3 | r g w |
| 9 | W 2 | – | R 3 | correct. |
| 10 | R 2 | – | R 3 | correct. |
| 11 | G 2 | R 1 | W 3 | correct. |

* First said g g w.

OBSERVER No. 6.

Distance 3,000 yards.

| | | | | |
|---|---|---|---|---|
| 1 | W 2 | W 1 | W 3 | w g w |
| 2 | G 2 | R 1 | W 3 | correct. |
| 3 | R 2 | W 1 | G 3 | r r r |
| 4 | R 2 | G 1 | G 3 | r r g* |
| 5 | W 2 | R 1 | G 3 | w r r |
| 6 | G 2 | – | R 3 | correct. |
| 7 | G 2 | – | W 3 | correct. |
| 8 | R 2 | – | R 3 | r w |
| 9 | W 2 | – | R 3 | correct. |
| 10 | G 2 | – | G 3 | correct. |
| 11 | G 2 | W 1 | R 3 | g r r |

* First gave correct reading.

Distance 2,000 yards.

| | | | | |
|---|---|---|---|---|
| 1 | W 2 | W 1 | W 3 | w r w |
| 2 | W 2 | R 1 | G 3 | correct. |
| 3 | W 2 | – | R 3 | correct. |
| 4 | R 2 | – | R 3 | r g |
| 5 | R 2 | W 1 | G 3 | r g g |
| 6 | R 2 | G 1 | G 3 | correct. |
| 7 | G 2 | R 1 | W 3 | correct. |
| 8 | G 2 | – | R 3 | correct. |
| 9 | G 2 | – | G 3 | correct. |
| 10 | G 2 | – | W 3 | correct. |
| 11 | G 2 | W 1 | R 3 | g r w |

Distance 1,000 yards.

| | | | | |
|---|---|---|---|---|
| 1 | W 2 | W 1 | W 3 | correct. |
| 2 | W 2 | – | G 3 | correct. |
| 3 | G 2 | – | G 3 | correct. |
| 4 | R 2 | G 1 | G 3 | correct. |
| 5 | G 2 | W 1 | R 3 | g r g |
| 6 | G 2 | W 1 | R 3 | g g w |
| 7 | G 2 | – | R 3 | g w |
| 8 | R 2 | W 1 | G 3 | r g w |
| 9 | W 2 | – | R 3 | correct. |
| 10 | R 2 | – | R 3 | correct. |
| 11 | G 2 | R 1 | W 3 | correct. |

OBSERVER No. 7.

Distance 3,000 yards.

| | | | | |
|---|---|---|---|---|
| 1 | W 2 | W 1 | W 3 | g w |
| 2 | G 2 | G 1 | W 3 | correct. |
| 3 | R 2 | – | R 3 | g r |
| 4 | W 2 | – | G 3 | w |
| 5 | W 2 | G 1 | G 3 | correct. |
| 6 | G 2 | R 1 | W 3 | g w |
| 7 | R 2 | W 1 | G 3 | r g |
| 8 | G 2 | – | W 3 | correct. |
| 9 | W 2 | W 1 | G 3 | w r g |
| 10 | R 2 | – | W 3 | correct. |
| 11 | G 2 | – | R 3 | correct. |

Distance 2,000 yards.

| | | | | |
|---|---|---|---|---|
| 1 | W 2 | – | W 3 | r w |
| 2 | R 2 | – | R 3 | correct. |
| 3 | R 2 | – | G 3 | correct. |
| 4 | R 2 | – | G 3 | correct. |
| 5 | G 2 | – | R 3 | correct. |
| 6 | G 2 | W 1 | R 3 | correct. |
| 7 | G 2 | – | W 3 | correct. |
| 8 | G 2 | R 1 | W 3 | g w w |
| 9 | G 2 | – | G 3 | correct. |
| 10 | W 2 | – | G 3 | w w |
| 11 | W 2 | – | R 3 | correct. |

Distance 2,000 yards (with binoculars).

| | | | | |
|---|---|---|---|---|
| 1 | W 2 | W 1 | W 3 | correct. |
| 2 | W 2 | – | R 3 | correct. |
| 3 | G 2 | – | R 3 | correct. |
| 4 | R 2 | – | R 3 | correct. |
| 5 | G 2 | W 1 | R 3 | correct. |
| 6 | W 2 | R 1 | G 3 | correct. |
| 7 | R 2 | W 1 | G 3 | correct. |
| 8 | G 2 | – | G 3 | correct. |
| 9 | R 2 | G 1 | G 3 | correct. |
| 10 | G 2 | R 1 | W 3 | correct. |
| 11 | G 2 | – | W 3 | correct. |

Distance 1,000 yards.

| | | | | |
|---|---|---|---|---|
| 1 | W 2 | W 1 | W 3 | w w |
| 2 | W 2 | G 1 | R 3 | g r |
| 3 | G 2 | G 1 | G 3 | correct. |
| 4 | R 2 | – | W 3 | correct. |
| 5 | G 2 | G 1 | W 3 | correct. |
| 6 | G 2 | – | G 3 | w g |
| 7 | R 2 | – | W 3 | correct. |
| 8 | R 2 | G 1 | W 3 | correct.* |
| 9 | G 2 | – | W 3 | correct. |
| 10 | W 2 | – | G 3 | correct. |
| 11 | R 2 | W 1 | G 3 | correct. |

* Second attempt.

OBSERVER No. 8.

Distance 3,000 yards.

| | | | | |
|---|---|---|---|---|
| 1 | W 2 | W 1 | W 3 | correct. |
| 2 | G 2 | G 1 | W 3 | correct. |
| 3 | R 2 | – | R 3 | correct. |
| 4 | W 2 | – | G 3 | correct. |
| 5 | W 2 | G 1 | G 3 | correct. |
| 6 | G 2 | R 1 | W 3 | correct. |
| 7 | R 2 | W 1 | G 3 | r g g |
| 8 | G 2 | – | W 3 | correct. |
| 9 | W 2 | W 1 | G 3 | correct. |
| 10 | R 2 | – | W 3 | correct. |
| 11 | G 2 | – | R 3 | correct. |

Distance 2,000 yards.

| | | | | |
|---|---|---|---|---|
| 1 | W 2 | – | W 3 | correct. |
| 2 | W 2 | – | G 3 | correct. |
| 3 | W 2 | – | R 3 | correct. |
| 4 | R 2 | – | R 3 | correct. |
| 5 | R 2 | W 1 | G 3 | r r g |
| 6 | R 2 | G 1 | G 3 | correct. |
| 7 | G 2 | – | W 3 | correct. |
| 8 | G 2 | – | R 3 | correct. |
| 9 | G 2 | – | G 3 | correct. |
| 10 | G 2 | – | W 3 | correct. |
| 11 | G 2 | – | R 3 | correct. |

Distance 1,000 yards.

| | | | | |
|---|---|---|---|---|
| 1 | W 2 | W 1 | W 3 | correct. |
| 2 | W 2 | G 1 | R 3 | correct. |
| 3 | G 2 | G 1 | G 3 | correct. |
| 4 | R 2 | – | W 3 | correct. |
| 5 | G 2 | G 1 | W 3 | correct. |
| 6 | G 2 | – | G 3 | correct. |
| 7 | R 2 | – | W 3 | correct. |
| 8 | R 2 | G 1 | W 3 | correct. |
| 9 | G 2 | – | W 3 | correct. |
| 10 | W 2 | – | G 3 | correct. |
| 11 | R 2 | W 1 | G 3 | correct. |



OBSERVER No. 9.

Distance 3,000 yards.

| Observation. | Lights shown. | | | Report. |
|---|---|---|---|---|
| 1 | W 2 | W 1 | W 3 | w g w |
| 2 | G 2 | G 1 | W 3 | g w |
| 3 | R 2 | – | R 3 | correct. |
| 4 | W 2 | – | G 3 | correct.* |
| 5 | W 2 | G 1 | G 3 | w w g |
| 6 | G 2 | R 1 | W 3 | correct. |
| 7 | R 2 | W 1 | G 3 | r r g |
| 8 | G 2 | – | W 3 | g r |
| 9 | W 2 | W 1 | G 3 | w r g |
| 10 | R 2 | – | W 3 | correct. |
| 11 | G 2 | – | R 3 | correct. |

* Doubtful as to the green.

Distance 2,000 yards.

| | | | | |
|---|---|---|---|---|
| 1 | W 2 | W 1 | W 3 | w r w |
| 2 | R 2 | – | R 3 | correct. |
| 3 | R 2 | W 1 | G 3 | correct. |
| 4 | R 2 | G 1 | G 3 | correct. |
| 5 | G 2 | – | R 3 | correct. |
| 6 | G 2 | W 1 | R 3 | g r r |
| 7 | G 2 | – | W 3 | correct. |
| 8 | G 2 | R 1 | W 3 | correct. |
| 9 | G 2 | – | G 3 | correct. |
| 10 | W 2 | R 1 | G 3 | correct. |
| 11 | W 2 | – | R 3 | correct. |

Distance 1,000 yards.

| | | | | |
|---|---|---|---|---|
| 1 | W 2 | W 1 | W 3 | correct. |
| 2 | W 2 | G 1 | R 3 | correct. |
| 3 | G 2 | G 1 | G 3 | correct. |
| 4 | R 2 | – | W 3 | correct. |
| 5 | G 2 | G 1 | W 3 | correct. |
| 6 | G 2 | – | G 3 | correct. |
| 7 | R 2 | – | W 3 | correct. |
| 8 | R 2 | G 1 | W 3 | correct. |
| 9 | G 2 | – | W 3 | correct. |
| 10 | W 2 | – | G 3 | correct. |
| 11 | R 2 | W 1 | G 3 | r r g |

THIRD NIGHT—FEBRUARY 2ND.

At the 3,000 yards distance there was sufficient haze to prevent the lights being seen. It was much clearer by the time the observations at 2,000 yards and 1,500 yards were taken, and quite clear at 1,000 yards and 500 yards.

OBSERVER No. 1.

Distance 2,000 yards.

| | | | | |
|---|---|---|---|---|
| 1 | W 3 | W 1 | W 2 | r r w |
| 2 | G 3 | R 1 | W 2 | correct. |
| 3 | R 3 | W 1 | G 2 | r g g |
| 4 | R 3 | G 1 | G 2 | correct. |
| 5 | W 3 | R 1 | G 2 | correct. |
| 6 | G 3 | – | R 2 | correct. |
| 7 | G 3 | – | W 2 | correct. |
| 8 | R 3 | – | R 2 | correct. |
| 9 | W 3 | – | R 2 | correct. |
| 10 | G 3 | – | G 2 | correct. |
| 11 | G 3 | W 1 | R 2 | correct. |

Distance 1,500 yards.

| | | | | |
|---|---|---|---|---|
| 1 | W 3 | W 1 | W 2 | correct. |
| 2 | W 3 | R 1 | G 2 | correct. |
| 3 | W 3 | – | R 2 | correct. |
| 4 | R 3 | – | R 2 | correct. |
| 5 | R 3 | W 1 | G 2 | correct. |
| 6 | R 3 | G 1 | W 2 | correct. |
| 7 | G 3 | R 1 | W 2 | correct. |
| 8 | G 3 | – | R 2 | correct. |
| 9 | G 3 | – | G 2 | correct. |
| 10 | G 3 | – | W 2 | correct. |
| 11 | G 3 | W 1 | R 2 | correct. |

Distance 1,000 yards.

| | | | | |
|---|---|---|---|---|
| 1 | W 3 | W 1 | W 2 | correct. |
| 2 | G 3 | – | R 2 | correct. |
| 3 | W 3 | R 1 | G 2 | correct. |
| 4 | R 3 | – | R 2 | correct. |
| 5 | G 3 | R 1 | W 2 | correct. |
| 6 | G 3 | – | W 2 | correct. |
| 7 | G 3 | W 1 | R 2 | correct. |
| 8 | W 3 | – | R 2 | correct. |
| 9 | R 3 | G 1 | G 2 | correct. |
| 10 | G 3 | – | G 2 | correct. |
| 11 | R 3 | W 1 | G 2 | correct. |

Distance 500 yards.

| | | | | |
|---|---|---|---|---|
| 1 | W 3 | W 1 | W 2 | correct. |
| 2 | G 3 | R 1 | W 2 | correct. |
| 3 | R 3 | W 1 | G 2 | correct. |
| 4 | R 3 | G 1 | G 2 | r w |
| 5 | W 3 | R 1 | G 2 | correct. |
| 6 | G 3 | – | R 2 | correct. |
| 7 | G 3 | – | W 2 | correct. |
| 8 | R 3 | – | R 2 | correct. |
| 9 | W 3 | – | R 2 | correct. |
| 10 | G 3 | – | G 2 | correct. |
| 11 | G 3 | W 1 | R 2 | correct. |

OBSERVER No. 2.

Distance 2,000 yards.

| | | | | |
|---|---|---|---|---|
| 1 | W 3 | W 1 | W 2 | r r w |
| 2 | G 3 | R 1 | W 2 | g g w |
| 3 | R 3 | W 1 | G 2 | r r g |
| 4 | R 3 | G 1 | G 2 | correct. |
| 5 | W 3 | R 1 | G 2 | w g g |
| 6 | G 3 | – | R 2 | correct. |
| 7 | G 3 | – | W 2 | r w |
| 8 | R 3 | – | R 2 | g r |
| 9 | W 3 | – | R 2 | r r |
| 10 | G 3 | – | G 2 | correct. |
| 11 | G 3 | W 1 | R 2 | r w g |

Distance 1,500 yards.

| | | | | |
|---|---|---|---|---|
| 1 | W 3 | W 1 | W 2 | r r w |
| 2 | W 3 | R 1 | G 2 | correct. |
| 3 | W 3 | – | R 2 | correct. |
| 4 | R 3 | – | R 2 | g r |
| 5 | R 3 | W 1 | G 2 | r r g |
| 6 | R 3 | G 1 | G 2 | correct. |
| 7 | G 3 | R 1 | W 2 | correct. |
| 8 | G 3 | – | R 2 | correct. |
| 9 | G 3 | – | G 2 | correct. |
| 10 | G 3 | – | W 2 | correct. |
| 11 | G 3 | W 1 | R 2 | g g r |

Distance 1,000 yards.

| | | | | |
|---|---|---|---|---|
| 1 | W 3 | W 1 | W 2 | w w r |
| 2 | G 3 | – | R 2 | correct. |
| 3 | W 3 | R 1 | G 2 | correct. |
| 4 | R 3 | – | R 2 | w r |
| 5 | G 3 | R 1 | W 2 | correct. |
| 6 | G 3 | – | W 2 | g g |
| 7 | G 3 | W 1 | R 2 | correct. |
| 8 | W 3 | – | R 2 | correct. |
| 9 | R 3 | G 1 | G 2 | r w g |
| 10 | G 3 | – | G 2 | r g |
| 11 | R 3 | W 1 | G 2 | correct. |

Distance 500 yards.

| | | | | |
|---|---|---|---|---|
| 1 | W 3 | W 1 | W 2 | w r r |
| 2 | G 3 | G 1 | W 2 | g w r* |
| 3 | G 3 | – | R 2 | correct. |
| 4 | W 3 | – | G 2 | w r |
| 5 | W 3 | G 1 | G 2 | r w r |
| 6 | G 3 | R 1 | W 2 | g r g |
| 7 | R 3 | W 1 | G 2 | correct. |
| 8 | G 3 | – | W 2 | g r |
| 9 | W 3 | W 1 | G 2 | g w r |
| 10 | R 3 | – | W 2 | r g |
| 11 | G 3 | – | R 2 | correct. |

The landward light (No. 2) was dim throughout this series.

* Second attempt.

### Observer No. 3.

Distance 2,000 yards.

| Observation. | Lights shown. | | | | Report. |
|---|---|---|---|---|---|
| 1 | W 3 | W 1 | W 2 | | } correct. |
| 2 | G 3 | – | G 2 | | |
| 3 | G 3 | – | R 2 | | |
| 4 | G 3 | – | W 2 | | |
| 5 | G 3 | – | W 2 | | |
| 6 | G 3 | – | R 2 | | |
| 7 | R 3 | – | R 2 | | correct.* |
| 8 | R 3 | – | G 2 | | w g |
| 9 | R 3 | – | G 2 | | correct. |
| 10 | W 3 | – | R 2 | | g r |
| 11 | W 3 | – | G 2 | | r g |

* Second attempt.

Distance 2,000 yards (with binoculars).

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 3 | W 1 | W 2 | | r r w |
| 2 | G 3 | R 1 | W 2 | | w r w |
| 3 | R 3 | W 1 | G 2 | | correct. |
| 4 | R 3 | G 1 | G 2 | | r w g |
| 5 | W 3 | R 1 | G 2 | | } |
| 6 | G 3 | – | R 2 | | |
| 7 | G 3 | – | W 2 | | } correct. |
| 8 | R 3 | – | R 2 | | |
| 9 | W 3 | – | G 2 | | } |
| 10 | G 3 | – | G 2 | | w g |
| 11 | G 3 | W 1 | R 2 | | correct. |

Distance 1,500 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 3 | W 1 | W 2 | | } |
| 2 | W 3 | R 1 | G 2 | | } correct. |
| 3 | W 3 | – | R 2 | | |
| 4 | R 3 | – | R 2 | | g r |
| 5 | R 3 | W 1 | G 2 | | } |
| 6 | R 3 | G 1 | G 2 | | |
| 7 | G 3 | R 1 | W 2 | | |
| 8 | G 3 | – | R 2 | | } correct. |
| 9 | G 3 | – | G 2 | | |
| 10 | G 3 | – | W 2 | | |
| 11 | G 3 | W 1 | R 2 | | } |

Distance 1,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 3 | W 1 | W 2 | | } |
| 2 | G 3 | – | R 2 | | } |
| 3 | W 3 | R 1 | G 2 | | } correct. |
| 4 | R 3 | – | R 2 | | } |
| 5 | G 3 | R 1 | W 2 | | } |
| 6 | G 3 | – | W 2 | | g r |
| 7 | G 3 | W 1 | R 2 | | } correct. |
| 8 | W 3 | – | R 2 | | } |
| 9 | R 3 | G 1 | G 2 | | r w g |
| 10 | G 3 | – | G 2 | | } correct. |
| 11 | R 3 | W 1 | G 2 | | } |

Distance 500 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 3 | W 1 | | | } |
| 2 | G 3 | R 1 | | | } |
| 3 | R 3 | W 1 | | | } |
| 4 | R 3 | G 1 | | | } |
| 5 | W 3 | R 1 | | | } |
| 6 | G 3 | – | | | } correct. |
| 7 | G 3 | – | | | } |
| 8 | R 3 | – | | | } |
| 9 | W 3 | – | | | } |
| 10 | G 3 | – | | | } |
| 11 | G 3 | W 1 | | | } |

### Observer No. 4.

Distance 2,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 3 | W 1 | W 2 | | } |
| 2 | G 3 | – | G 2 | | } |
| 3 | G 3 | – | R 2 | | } |
| 4 | G 3 | R 1 | W 2 | | } |
| 5 | G 3 | – | W 2 | | } |
| 6 | G 3 | W 1 | R 2 | | } correct. |
| 7 | R 3 | – | R 2 | | } |
| 8 | R 3 | G 1 | G 2 | | } |
| 9 | R 3 | W 1 | G 2 | | } |
| 10 | W 3 | – | R 2 | | } |
| 11 | W 3 | R 1 | G 2 | | } |

Distance 2,000 yards (with binoculars).

| Observation. | Lights shown. | | | | Report. |
|---|---|---|---|---|---|
| 1 | W 3 | W 1 | W 2 | | } |
| 2 | R 3 | W 1 | G 2 | | } |
| 3 | W 3 | R 1 | G 2 | | } |
| 4 | G 3 | – | W 2 | | } |
| 5 | W 3 | – | R 2 | | } |
| 6 | G 3 | W 1 | R 2 | | } correct |
| 7 | G 3 | – | G 2 | | } |
| 8 | R 3 | – | R 2 | | } |
| 9 | G 3 | – | R 2 | | } |
| 10 | R 3 | G 1 | G 2 | | } |
| 11 | G 3 | R 1 | W 2 | | } |

Distance 1,500 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 3 | W 1 | W 2 | | } |
| 2 | W 3 | – | R 2 | | } |
| 3 | G 3 | – | R 2 | | } |
| 4 | R 3 | – | R 2 | | } |
| 5 | G 3 | W 1 | R 2 | | } |
| 6 | W 3 | R 1 | G 2 | | } correct. |
| 7 | R 3 | W 1 | G 2 | | } |
| 8 | G 3 | – | G 2 | | } |
| 9 | R 3 | G 1 | G 2 | | } |
| 10 | G 3 | R 1 | W 2 | | } |
| 11 | G 3 | – | W 2 | | } |

### Observer No. 5.

Distance 2,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 3 | W 1 | W 2 | | g g w |
| 2 | R 3 | W 1 | G 2 | | } |
| 3 | W 3 | R 1 | G 2 | | } correct. |
| 4 | G 3 | – | W 2 | | } |
| 5 | W 3 | – | R 2 | | g r |
| 6 | G 3 | W 1 | R 2 | | } |
| 7 | G 3 | – | G 2 | | } |
| 8 | R 3 | – | R 2 | | } correct. |
| 9 | G 3 | – | R 2 | | } |
| 10 | R 3 | G 1 | G 2 | | } |
| 11 | G 3 | R 1 | W 2 | | } |

Distance 1,500 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 3 | W 1 | W 2 | | } |
| 2 | W 3 | – | R 2 | | } |
| 3 | G 3 | – | R 2 | | } correct. |
| 4 | R 3 | – | R 2 | | } |
| 5 | G 3 | W 1 | R 2 | | } |
| 6 | W 3 | R 1 | G 2 | | g w r |
| 7 | R 3 | W 1 | G 2 | | r g g |
| 8 | G 3 | – | G 2 | | } |
| 9 | R 3 | G 1 | G 2 | | } correct. |
| 10 | G 3 | R 1 | W 2 | | } |
| 11 | G 3 | – | W 2 | | } |

Distance 1,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 3 | W 1 | W 2 | | } |
| 2 | W 3 | G 1 | R 2 | | } correct. |
| 3 | G 3 | G 1 | G 2 | | } |
| 4 | R 3 | – | W 2 | | r g |
| 5 | G 3 | – | G 2 | | } |
| 6 | W 3 | R 1 | G 2 | | } |
| 7 | R 3 | W 1 | G 2 | | } |
| 8 | G 3 | – | G 2 | | } correct. |
| 9 | R 3 | G 1 | G 2 | | } |
| 10 | G 3 | R 1 | W 2 | | } |
| 11 | G 3 | – | W 2 | | } |

Distance 500 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 3 | W 1 | W 2 | | } |
| 2 | R 3 | W 1 | G 2 | | } |
| 3 | W 3 | – | R 2 | | } |
| 4 | G 3 | – | R 2 | | } |
| 5 | G 3 | W 1 | R 2 | | } |
| 6 | G 3 | – | G 2 | | } |
| 7 | R 3 | – | G 2 | | } correct. |
| 8 | R 3 | – | R 2 | | } |
| 9 | G 3 | – | R 2 | | } |
| 10 | R 3 | G 1 | G 2 | | } |
| 11 | G 3 | R 1 | W 2 | | } |



### Observer No. 6.

Distance 2,000 yards.

| Observation. | Lights shown. | | | | Report. |
|---|---|---|---|---|---|
| 1 | W 3 | W 1 | W 2 | | correct. |
| 2 | R 3 | W 1 | G 2 | | r g g |
| 3 | W 3 | R 1 | G 2 | | r r g |
| 4 | G 3 | – | W 2 | | r w |
| 5 | W 3 | – | R 2 | | g r |
| 6 | G 3 | W 1 | R 2 | | g g r |
| 7 | G 3 | – | G 2 | | } |
| 8 | R 3 | – | R 2 | | } |
| 9 | G 3 | – | R 2 | | } correct. |
| 10 | R 3 | G 1 | G 2 | | } |
| 11 | G 3 | R 1 | W 2 | | r r w |

Distance 1,500 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 3 | W 1 | W 2 | | correct. |
| 2 | W 3 | – | R 2 | | g r * |
| 3 | G 3 | – | R 2 | | } |
| 4 | R 3 | – | R 2 | | } correct. |
| 5 | G 3 | W 1 | R 2 | | g g r |
| 6 | W 3 | R 1 | G 2 | | g r g |
| 7 | R 3 | W 1 | G 2 | | r g g |
| 8 | G 3 | – | G 2 | | correct.† |
| 9 | R 3 | G 1 | G 2 | | } |
| 10 | G 3 | R 1 | W 2 | | } correct. |
| 11 | G 3 | – | W 2 | | } |

* Corrected to wr after he had seen the next lights.
† Second attempt.

Distance 1,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 3 | W 1 | W 2 | | } |
| 2 | W 3 | G 1 | R 2 | | } correct. |
| 3 | G 3 | G 1 | G 2 | | g g w |
| 4 | R 3 | – | W 2 | | r g |
| 5 | G 3 | G 1 | W 2 | | g g r |
| 6 | G 3 | – | G 2 | | } |
| 7 | R 3 | – | W 2 | | } correct. |
| 8 | R 3 | G 1 | W 2 | | r g g |
| 9 | G 3 | – | W 2 | | correct. |
| 10 | W 3 | – | G 2 | | w r |
| 11 | R 3 | W 1 | G 2 | | correct. |

Distance 500 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 3 | W 1 | | | } |
| 2 | G 3 | R 1 | | | } correct. |
| 3 | R 3 | W 1 | | | correct.* |
| 4 | R 3 | G 1 | | | } |
| 5 | W 3 | R 1 | | | } correct. |
| 6 | G 3 | | | | correct. |
| 7 | G 3 | | | | w |
| 8 | R 3 | | | | } |
| 9 | W 3 | | | | } |
| 10 | G 3 | | | | } correct. |
| 11 | G 3 | W 1 | | | } |

* Second attempt.

### Observer No. 7.

Distance 2,000 yards (with binoculars).

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 3 | W 1 | W 2 | | } |
| 2 | G 3 | – | W 2 | | } |
| 3 | G 3 | – | G 2 | | } |
| 4 | R 3 | G 1 | G 2 | | } |
| 5 | W 3 | R 1 | G 2 | | } |
| 6 | G 3 | W 1 | R 2 | | } correct. |
| 7 | G 3 | – | R 2 | | } |
| 8 | R 3 | W 1 | G 2 | | } |
| 9 | W 3 | – | R 2 | | } |
| 10 | R 3 | – | R 2 | | } |
| 11 | G 3 | R 1 | W 2 | | } |

Distance 1,500 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 3 | W 1 | W 2 | | correct. |
| 2 | R 3 | – | R 2 | | r r r |
| 3 | R 3 | W 1 | G 2 | | r g |
| 4 | R 3 | G 1 | G 2 | | r w g |
| 5 | G 3 | – | R 2 | | } |
| 6 | G 3 | W 1 | R 2 | | } correct. |
| 7 | G 3 | – | W 2 | | g g w |
| 8 | G 3 | R 1 | W 2 | | correct. |
| 9 | G 3 | – | G 2 | | g g w |
| 10 | W 3 | R 1 | G 2 | | correct. |
| 11 | W 3 | – | R 2 | | g w r |

Distance 1,000 yards.

| Observation. | Lights shown. | | | | Report. |
|---|---|---|---|---|---|
| 1 | W 3 | W 1 | W 2 | | w r w |
| 2 | W 3 | G 1 | R 2 | | correct. |
| 3 | G 3 | G 1 | G 2 | | w g g |
| 4 | R 3 | – | W 2 | | r g w |
| 5 | G 3 | G 1 | W 2 | | correct. |
| 6 | G 3 | – | G 2 | | g w |
| 7 | R 3 | – | W 2 | | r g |
| 8 | R 3 | G 1 | W 2 | | r g g |
| 9 | G 3 | – | W 2 | | } |
| 10 | W 3 | – | G 2 | | } correct. |
| 11 | R 3 | W 1 | G 2 | | r r w |

Distance 500 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 3 | W 1 | W 2 | | w w g |
| 2 | G 3 | G 1 | W 2 | | g g |
| 3 | G 3 | – | R 2 | | } |
| 4 | W 3 | – | G 2 | | } correct. |
| 5 | W 3 | G 1 | G 2 | | w g |
| 6 | G 3 | R 1 | W 2 | | correct. |
| 7 | R 3 | W 1 | G 2 | | r w |
| 8 | G 3 | – | W 2 | | correct. |
| 9 | W 3 | W 1 | G 2 | | w w |
| 10 | R 3 | – | W 2 | | r g |
| 11 | G 3 | – | R 2 | | correct. |

The landward light (No. 2) was dim throughout this series.

### Observer No. 8.

Distance 2,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 3 | W 1 | W 2 | | correct. |
| 2 | G 3 | – | W 2 | | g g w |
| 3 | G 3 | – | G 2 | | g g g |
| 4 | R 3 | G 1 | G 2 | | } |
| 5 | W 3 | R 1 | G 2 | | } |
| 6 | G 3 | W 1 | R 2 | | } |
| 7 | G 3 | – | R 2 | | } correct. |
| 8 | R 3 | W 1 | G 2 | | } |
| 9 | W 3 | – | R 2 | | } |
| 10 | R 3 | – | R 2 | | } |
| 11 | G 3 | R 1 | W 2 | | } |

Distance 1,500 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 3 | W 1 | W 2 | | } |
| 2 | R 3 | – | R 2 | | } |
| 3 | R 3 | W 1 | G 2 | | } |
| 4 | R 3 | G 1 | G 2 | | } |
| 5 | G 3 | – | R 2 | | } |
| 6 | G 3 | W 1 | R 2 | | } correct. |
| 7 | G 3 | – | W 2 | | } |
| 8 | R 3 | G 1 | W 2 | | } |
| 9 | G 3 | – | G 2 | | } |
| 10 | W 3 | R 1 | G 2 | | } |
| 11 | W 3 | – | R 2 | | } |

### Observer No. 9.

Distance 2,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 3 | W 1 | W 2 | | r r w |
| 2 | G 3 | – | W 2 | | w |
| 3 | G 3 | – | G 2 | | } |
| 4 | R 3 | G 1 | G 2 | | } correct. |
| 5 | W 3 | R 1 | G 2 | | r r g |
| 6 | G 3 | W 1 | R 2 | | r r |
| 7 | G 3 | – | R 2 | | r |
| 8 | R 3 | W 1 | G 2 | | r r g |
| 9 | W 3 | – | R 2 | | r r |
| 10 | R 3 | – | R 2 | | correct. |
| 11 | G 3 | R 1 | W 2 | | r w |

2,000 yards (with binoculars).

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 3 | W 1 | W 2 | | } |
| 2 | G 3 | – | G 2 | | } |
| 3 | G 3 | – | R 2 | | } |
| 4 | G 3 | R 1 | W 2 | | } |
| 5 | G 3 | – | W 2 | | } |
| 6 | G 3 | W 1 | R 2 | | } correct |
| 7 | R 3 | – | R 2 | | } |
| 8 | R 3 | G 1 | G 2 | | } |
| 9 | R 3 | W 1 | G 2 | | } |
| 10 | W 3 | – | R 2 | | } |
| 11 | W 3 | R 1 | G 2 | | } |

Distance 1,500 yards.

| Observation. | Lights shown. | | | | Report. |
|---|---|---|---|---|---|
| 1 | W 3 | W 1 | W 2 | - - | |
| 2 | R 3 | – | R 2 | - - | |
| 3 | R 3 | W 1 | G 2 | - - | |
| 4 | R 3 | G 1 | G 2 | - - | |
| 5 | G 3 | – | R 2 | - - | |
| 6 | G 3 | W 1 | R 2 | - - | correct. |
| 7 | G 3 | – | W 2 | - - | |
| 8 | G 3 | R 1 | W 2 | - - | |
| 9 | G 3 | – | G 2 | - - | |
| 10 | W 3 | R 1 | G 2 | - - | |
| 11 | W 3 | – | R 2 | - - | |

## FOURTH NIGHT—FEBRUARY 3rd.

The weather throughout was quite clear.

### Observer No. 1.

Distance 3,000 yards.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | - | W 1 | W 3 | W 2 | - | - | r r w |
| 2 | - | G 1 | – | G 2 | - | - | correct. |
| 3 | - | G 1 | – | R 2 | - | - | |
| 4 | - | G 1 | R 3 | W 2 | - | - | g w w |
| 5 | - | G 1 | – | W 2 | - | - | correct. |
| 6 | - | G 1 | W 3 | R 2 | - | - | g g r |
| 7 | - | R 1 | – | R 2 | - | - | |
| 8 | - | R 1 | G 3 | G 2 | - | - | |
| 9 | - | R 1 | W 3 | G 2 | - | - | correct. |
| 10 | - | W 1 | – | R 2 | - | - | |
| 11 | - | W 1 | R 3 | G 2 | - | - | |

Distance 2,000 yards.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | - | W 1 | W 3 | W 2 | - | - | |
| 2 | - | W 1 | G 3 | R 2 | - | - | correct. |
| 3 | - | G 1 | G 3 | G 2 | - | - | g r g |
| 4 | - | R 1 | – | W 2 | - | - | |
| 5 | - | G 1 | G 3 | W 2 | - | - | |
| 6 | - | G 1 | – | G 2 | - | - | correct. |
| 7 | - | R 1 | – | W 2 | - | - | |
| 8 | - | R 1 | G 3 | W 2 | - | - | |
| 9 | - | G 1 | – | W 2 | - | - | |
| 10 | - | W 1 | – | G 2 | - | - | r g |
| 11 | - | R 1 | W 3 | G 2 | - | - | correct. |

Distance 1,500 yards.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | - | W 1 | W 3 | W 2 | - | - | |
| 2 | - | G 1 | – | W 2 | - | - | |
| 3 | - | G 1 | – | G 2 | - | - | |
| 4 | - | R 1 | G 3 | G 2 | - | - | |
| 5 | - | W 1 | R 3 | G 2 | - | - | |
| 6 | - | G 1 | W 3 | R 2 | - | - | correct. |
| 7 | - | G 1 | – | R 2 | - | - | |
| 8 | - | R 1 | W 3 | G 2 | - | - | |
| 9 | - | W 1 | – | R 2 | - | - | |
| 10 | - | R 1 | – | R 2 | - | - | |
| 11 | - | G 1 | R 3 | W 2 | - | - | |

Distance 1,000 yards.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | - | W 1 | W 3 | W 2 | - | - | |
| 2 | - | R 1 | W 3 | G 2 | - | - | |
| 3 | - | W 1 | R 3 | G 2 | - | - | |
| 4 | - | G 1 | – | W 2 | - | - | |
| 5 | - | W 1 | – | R 2 | - | - | |
| 6 | - | G 1 | W 3 | R 2 | - | - | correct. |
| 7 | - | G 1 | – | G 2 | - | - | |
| 8 | - | R 1 | – | R 2 | - | - | |
| 9 | - | G 1 | – | R 2 | - | - | |
| 10 | - | R 1 | G 3 | G 2 | - | - | |
| 11 | - | G 1 | R 3 | W 2 | - | - | |

### Observer No. 2.

Distance 3,000 yards.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | - | W 1 | W 3 | W 2 | - | - | g r w |
| 2 | - | G 1 | – | G 2 | - | - | |
| 3 | - | G 1 | – | R 2 | - | - | |
| 4 | - | G 1 | R 3 | W 2 | - | - | correct. |
| 5 | - | G 1 | – | W 2 | - | - | |
| 6 | - | G 1 | W 3 | R 2 | - | - | g r w |
| 7 | - | R 1 | – | R 2 | - | - | |
| 8 | - | R 1 | G 3 | G 2 | - | - | correct. |
| 9 | - | R 1 | W 3 | G 2 | - | - | r g g |
| 10 | - | W 1 | – | R 2 | - | - | r r |
| 11 | - | W 1 | R 3 | G 2 | - | - | g r g |

Distance 2,000 yards.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | - | W 1 | W 3 | W 2 | - | - | w r w |
| 2 | - | W 1 | G 3 | R 2 | - | - | correct. |
| 3 | - | G 1 | G 3 | G 2 | - | - | r g g |
| 4 | - | R 1 | – | W 2 | - | - | correct. |
| 5 | - | G 1 | G 3 | W 2 | - | - | g r w |
| 6 | - | G 1 | – | G 2 | - | - | |
| 7 | - | R 1 | – | W 2 | - | - | correct. |
| 8 | - | R 1 | G 3 | W 2 | - | - | |
| 9 | - | G 1 | – | W 2 | - | - | g r |
| 10 | - | W 1 | – | G 2 | - | - | g g |
| 11 | - | R 1 | W 3 | G 2 | - | - | r g g |

Distance 1,500 yards.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | - | W 1 | W 3 | W 2 | - | - | g r w |
| 2 | - | G 1 | – | W 2 | - | - | |
| 3 | - | G 1 | – | G 2 | - | - | |
| 4 | - | R 1 | G 3 | G 2 | - | - | correct. |
| 5 | - | W 1 | R 3 | G 2 | - | - | |
| 6 | - | G 1 | W 3 | R 2 | - | - | g g r |
| 7 | - | G 1 | – | R 2 | - | - | |
| 8 | - | R 1 | W 3 | G 2 | - | - | correct. |
| 9 | - | W 1 | – | R 2 | - | - | g r |
| 10 | - | R 1 | – | R 2 | - | - | |
| 11 | - | G 1 | R 3 | W 2 | - | - | correct. |

Distance 1,000 yards.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | - | W 1 | W 3 | W 2 | - | - | |
| 2 | - | R 1 | W 3 | G 2 | - | - | correct. |
| 3 | - | W 1 | – | R 2 | - | - | |
| 4 | - | G 1 | – | W 2 | - | - | |
| 5 | - | W 1 | – | R 2 | - | - | g r |
| 6 | - | G 1 | W 3 | R 2 | - | - | g g r* |
| 7 | - | G 1 | – | G 2 | - | - | |
| 8 | - | R 1 | – | R 2 | - | - | |
| 9 | - | G 1 | – | R 2 | - | - | correct. |
| 10 | - | R 1 | G 3 | G 2 | - | - | |
| 11 | - | G 1 | R 3 | W 2 | - | - | |

* Second attempt.

### Observer No. 3.

Distance 3,000 yards.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | - | W 1 | W 3 | W 2 | - | - | g g w* |
| 2 | - | G 1 | – | G 2 | - | - | |
| 3 | - | G 1 | – | R 2 | - | - | |
| 4 | - | G 1 | R 3 | W 2 | - | - | |
| 5 | - | G 1 | – | W 2 | - | - | correct. |
| 6 | - | G 1 | W 3 | R 2 | - | - | |
| 7 | - | R 1 | – | R 2 | - | - | |
| 8 | - | R 1 | G 3 | G 2 | - | - | |
| 9 | - | R 1 | W 3 | G 2 | - | - | r g g |
| 10 | - | W 1 | – | R 2 | - | - | g r |
| 11 | - | W 1 | R 3 | W 2 | - | - | r w g |

* Hesitated.

Distance 2,000 yards.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | - | W 1 | W 3 | W 2 | - | - | |
| 2 | - | W 1 | G 3 | R 2 | - | - | correct. |
| 3 | - | G 1 | G 3 | G 2 | - | - | g g w |
| 4 | - | R 1 | – | W 2 | - | - | |
| 5 | - | G 1 | G 3 | W 2 | - | - | |
| 6 | - | G 1 | – | G 2 | - | - | |
| 7 | - | R 1 | – | W 2 | - | - | |
| 8 | - | R 1 | G 3 | W 2 | - | - | correct. |
| 9 | - | G 1 | – | W 2 | - | - | |
| 10 | - | W 1 | – | G 2 | - | - | |
| 11 | - | R 1 | W 3 | G 2 | - | - | |

Distance 1,500 yards.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | - | W 1 | W 3 | W 2 | - | - | w g w |
| 2 | - | G 1 | – | W 2 | - | - | |
| 3 | - | G 1 | – | G 2 | - | - | correct. |
| 4 | - | R 1 | G 3 | G 2 | - | - | r g w |
| 5 | - | W 1 | R 3 | G 2 | - | - | w r w |
| 6 | - | G 1 | W 3 | R 2 | - | - | |
| 7 | - | G 1 | – | R 2 | - | - | |
| 8 | - | R 1 | W 3 | G 2 | - | - | |
| 9 | - | W 1 | – | R 2 | - | - | correct. |
| 10 | - | R 1 | – | R 2 | - | - | |
| 11 | - | G 1 | R 3 | W 2 | - | - | |



Distance 1,000 yards.

| Observation. | Lights shown. | | | | Report. |
|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | - - | |
| 2 | R 1 | W 3 | G 2 | - - | |
| 3 | W 1 | R 3 | G 2 | - - | |
| 4 | G 1 | – | W 2 | - - | |
| 5 | W 1 | – | R 2 | - - | correct. |
| 6 | G 1 | W 3 | R 2 | - - | |
| 7 | G 1 | – | G 2 | - - | |
| 8 | R 1 | – | R 2 | - - | |
| 9 | G 1 | – | R 2 | - - | |
| 10 | R 1 | G 3 | G 2 | - - | r g w |
| 11 | G 1 | R 3 | W 2 | - - | correct. |

### Observer No. 4.

Distance 3,000 yards.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | - | W 1 | W 3 | W 2 | - | - | |
| 2 | - | W 1 | R 3 | G 2 | - | - | |
| 3 | - | W 1 | – | R 2 | - | - | |
| 4 | - | R 1 | – | R 2 | - | - | |
| 5 | - | R 1 | W 3 | G 2 | - | - | |
| 6 | - | R 1 | G 3 | G 2 | - | - | correct. |
| 7 | - | G 1 | R 3 | W 2 | - | - | |
| 8 | - | G 1 | – | R 2 | - | - | |
| 9 | - | G 1 | – | G 2 | - | - | |
| 10 | - | G 1 | – | W 2 | - | - | |
| 11 | - | G 1 | W 3 | R 2 | - | - | |

Distance 2,000 yards.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | - | W 1 | W 3 | W 2 | - | - | |
| 2 | - | G 1 | – | R 2 | - | - | |
| 3 | - | W 1 | R 3 | G 2 | - | - | |
| 4 | - | R 1 | – | R 2 | - | - | |
| 5 | - | G 1 | R 3 | W 2 | - | - | |
| 6 | - | G 1 | – | W 2 | - | - | correct. |
| 7 | - | G 1 | W 3 | R 2 | - | - | |
| 8 | - | W 1 | – | R 2 | - | - | |
| 9 | - | R 1 | G 3 | G 2 | - | - | |
| 10 | - | G 1 | – | G 2 | - | - | |
| 11 | - | R 1 | W 3 | G 2 | - | - | |

### Observer No. 5.

Distance 3,000 yards.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | - | W 1 | W 3 | W 2 | - | - | |
| 2 | - | G 1 | G 3 | W 2 | - | - | correct. |
| 3 | - | R 1 | – | R 2 | - | - | |
| 4 | - | W 1 | – | G 2 | - | - | r g |
| 5 | - | W 1 | G 3 | G 2 | - | - | g r g |
| 6 | - | G 1 | R 3 | W 2 | - | - | correct. |
| 7 | - | R 1 | W 3 | G 2 | - | - | r g g |
| 8 | - | G 1 | – | W 2 | - | - | correct. |
| 9 | - | W 1 | W 3 | G 2 | - | - | w r g |
| 10 | - | R 1 | – | W 2 | - | - | correct. |
| 11 | - | G 1 | – | R 2 | - | - | r r |

Distance 2,000 yards.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | - | W 1 | W 3 | W 2 | - | - | correct. |
| 2 | - | G 1 | – | R 2 | - | - | w r |
| 3 | - | R 1 | W 3 | G 2 | - | - | |
| 4 | - | R 1 | – | R 2 | - | - | |
| 5 | - | G 1 | R 3 | W 2 | - | - | correct. |
| 6 | - | G 1 | – | W 2 | - | - | |
| 7 | - | G 1 | W 3 | R 2 | - | - | |
| 8 | - | W 1 | – | R 2 | - | - | g r |
| 9 | - | R 1 | G 3 | G 2 | - | - | r g w |
| 10 | - | G 1 | – | G 2 | - | - | |
| 11 | - | R 1 | W 3 | G 2 | - | - | correct. |

Distance 1,500 yards.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | - | W 1 | W 3 | W 2 | - | - | |
| 2 | - | W 1 | – | R 2 | - | - | |
| 3 | - | G 1 | – | R 2 | - | - | |
| 4 | - | R 1 | – | R 2 | - | - | |
| 5 | - | G 1 | W 3 | R 2 | - | - | |
| 6 | - | W 1 | R 3 | G 2 | - | - | correct. |
| 7 | - | R 1 | W 3 | G 2 | - | - | |
| 8 | - | G 1 | – | G 2 | - | - | |
| 9 | - | R 1 | G 3 | G 2 | - | - | r g w* |
| 10 | - | G 1 | R 3 | W 2 | - | - | |
| 11 | - | G 1 | – | W 2 | - | - | correct. |

* Second attempt.

Distance 1,000 yards.

| Observation. | Lights shown. | | | | Report. |
|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | - - | |
| 2 | G 1 | R 3 | W 2 | - - | correct. |
| 3 | R 1 | W 3 | G 2 | - - | r g g* |
| 4 | R 1 | G 3 | G 2 | - - | |
| 5 | W 1 | R 3 | G 2 | - - | |
| 6 | G 1 | – | R 2 | - - | |
| 7 | G 1 | – | W 2 | - - | correct. |
| 8 | R 1 | – | R 2 | - - | |
| 9 | W 1 | – | R 2 | - - | |
| 10 | G 1 | – | G 2 | - - | |
| 11 | G 1 | W 3 | R 2 | - - | |

* His first report was correct, but he changed his mind.

### Observer No. 6.

Distance 3,000 yards.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | - | W 1 | W 3 | W 2 | - | - | |
| 2 | - | G 1 | G 3 | W 2 | - | - | correct. |
| 3 | - | R 1 | – | R 2 | - | - | |
| 4 | - | W 1 | – | G 2 | - | - | g g |
| 5 | - | W 1 | G 3 | G 2 | - | - | g r g* |
| 6 | - | G 1 | R 3 | W 2 | - | - | correct. |
| 7 | - | R 1 | W 3 | G 2 | - | - | r g g |
| 8 | - | G 1 | – | W 2 | - | - | correct. |
| 9 | - | W 1 | W 3 | G 2 | - | - | g g g |
| 10 | - | R 1 | – | W 2 | - | - | correct. |
| 11 | - | G 1 | – | R 2 | - | - | correct.* |

* Second attempt.

Distance 2,000 yards.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | - | W 1 | W 3 | W 2 | - | - | |
| 2 | - | G 1 | – | R 2 | - | - | correct. |
| 3 | - | W 1 | R 3 | G 2 | - | - | g r g |
| 4 | - | R 1 | – | R 2 | - | - | |
| 5 | - | G 1 | R 3 | W 2 | - | - | correct. |
| 6 | - | G 1 | – | W 2 | - | - | |
| 7 | - | G 1 | W 3 | R 2 | - | - | g g r |
| 8 | - | W 1 | – | R 2 | - | - | g r |
| 9 | - | R 1 | G 3 | G 2 | - | - | |
| 10 | - | G 1 | – | G 2 | - | - | correct. |
| 11 | - | R 1 | W 3 | G 2 | - | - | r g g |

Distance 1,500 yards.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | - | W 1 | W 3 | W 2 | - | - | |
| 2 | - | W 1 | – | R 2 | - | - | |
| 3 | - | G 1 | – | R 2 | - | - | correct. |
| 4 | - | R 1 | – | R 2 | - | - | |
| 5 | - | G 1 | W 3 | R 2 | - | - | |
| 6 | - | G 1 | R 3 | W 2 | - | - | g r g |
| 7 | - | R 1 | W 3 | G 2 | - | - | r g g |
| 8 | - | G 1 | – | G 2 | - | - | |
| 9 | - | R 1 | G 3 | G 2 | - | - | correct. |
| 10 | - | G 1 | R 3 | W 2 | - | - | |
| 11 | - | G 1 | – | W 2 | - | - | |

Distance 1,000 yards.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | - | W 1 | W 3 | W 2 | - | - | |
| 2 | - | G 1 | R 3 | G 2 | - | - | |
| 3 | - | R 1 | W 3 | G 2 | - | - | |
| 4 | - | R 1 | G 3 | G 2 | - | - | |
| 5 | - | W 1 | R 3 | G 2 | - | - | correct. |
| 6 | - | G 1 | – | R 2 | - | - | |
| 7 | - | G 1 | W 3 | R 2 | - | - | |
| 8 | - | R 1 | – | R 2 | - | - | |
| 9 | - | W 1 | – | R 2 | - | - | |
| 10 | - | G 1 | – | G 2 | - | - | |
| 11 | - | G 1 | W 3 | R 2 | - | - | w w r |

### Observer No. 7.

Distance 3,000 yards.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | - | W 1 | W 3 | W 2 | - | - | g w |
| 2 | - | G 1 | G 3 | W 2 | - | - | w r |
| 3 | - | R 1 | – | R 2 | - | - | r |
| 4 | - | W 1 | – | G 2 | - | - | g w |
| 5 | - | W 1 | G 3 | G 2 | - | - | g w |
| 6 | - | G 1 | R 3 | W 2 | - | - | g g w |
| 7 | - | R 1 | W 3 | G 2 | - | - | g w |
| 8 | - | G 1 | – | W 2 | - | - | w g |
| 9 | - | W 1 | W 3 | G 2 | - | - | g w |
| 10 | - | R 1 | – | W 2 | - | - | w g |
| 11 | - | G 1 | – | R 2 | - | - | correct. |

Distance 2,000 yards.

| Observation. | Lights shown. | | | | Report. |
|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | | correct. |
| 2 | R 1 | – | R 2 | | |
| 3 | R 1 | W 3 | G 2 | | w g g |
| 4 | R 1 | G 3 | G 2 | | g g g |
| 5 | G 1 | – | R 2 | | g r r |
| 6 | G 1 | W 3 | R 2 | | g r |
| 7 | G 1 | – | W 2 | | g g w* |
| 8 | G 1 | R 3 | W 2 | | g w w |
| 9 | G 1 | – | G 2 | | w g g |
| 10 | W 1 | R 3 | G 2 | | g g |
| 11 | W 1 | – | R 2 | | g r |

* Second attempt.

Distance 1,500 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | | correct. |
| 2 | W 1 | – | R 2 | | |
| 3 | G 1 | – | R 2 | | |
| 4 | R 1 | – | R 2 | | |
| 5 | G 1 | W 3 | R 2 | | |
| 6 | W 1 | R 3 | G 2 | | r w g |
| 7 | R 1 | W 3 | G 2 | | r g g |
| 8 | G 1 | – | G 2 | | correct. |
| 9 | R 1 | G 3 | G 2 | | |
| 10 | G 1 | R 3 | W 2 | | |
| 11 | G 1 | – | W 2 | | |

Distance 1,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | | correct. |
| 2 | G 1 | R 3 | W 2 | | |
| 3 | R 1 | W 3 | G 2 | | |
| 4 | R 1 | G 3 | G 2 | | |
| 5 | W 1 | R 3 | G 2 | | |
| 6 | G 1 | – | R 2 | | |
| 7 | G 1 | – | W 2 | | |
| 8 | R 1 | – | R 2 | | |
| 9 | W 1 | – | R 2 | | |
| 10 | G 1 | – | G 2 | | |
| 11 | G 1 | W 3 | R 2 | | |

OBSERVER No. 8.

Distance 3,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 3 | W 1 | W 2 | | correct. |
| 2 | W 3 | R 1 | G 2 | | |
| 3 | W 3 | – | R 2 | | |
| 4 | R 3 | – | R 2 | | |
| 5 | R 3 | W 1 | G 2 | | |
| 6 | R 3 | G 1 | G 2 | | |
| 7 | G 3 | R 1 | W 2 | | |
| 8 | G 3 | – | R 2 | | |
| 9 | G 3 | – | G 2 | | |
| 10 | G 3 | – | W 2 | | |
| 11 | G 3 | W 1 | R 2 | | |

Distance 2,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | | correct. |
| 2 | R 1 | – | R 2 | | |
| 3 | R 1 | W 3 | G 2 | | |
| 4 | R 1 | G 3 | G 2 | | |
| 5 | G 1 | – | R 2 | | |
| 6 | G 1 | W 3 | R 2 | | |
| 7 | G 1 | – | W 2 | | |
| 8 | G 1 | R 3 | W 2 | | |
| 9 | G 1 | – | G 2 | | |
| 10 | W 1 | R 3 | G 2 | | |
| 11 | W 1 | – | R 2 | | |

OBSERVER No. 9.

Distance 3,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | | r r w |
| 2 | W 1 | R 3 | G 2 | | r r g |
| 3 | W 1 | – | R 2 | | correct. |
| 4 | R 1 | – | R 2 | | |
| 5 | R 1 | W 3 | G 2 | | w w g |
| 6 | R 1 | G 3 | G 2 | | r g |
| 7 | G 1 | R 3 | W 2 | | correct. |
| 8 | G 1 | – | R 2 | | |
| 9 | G 1 | – | G 2 | | w g |
| 10 | G 1 | – | W 2 | | w |
| 11 | G 1 | W 3 | R 2 | | w r |

Distance 2,000 yards.

| Observation. | Lights shown. | | | | Report. |
|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | | r r w |
| 2 | R 1 | – | R 2 | | correct. |
| 3 | R 1 | W 3 | G 2 | | r r g |
| 4 | R 1 | G 3 | G 2 | | r g |
| 5 | G 1 | – | R 2 | | correct. |
| 6 | G 1 | W 3 | R 2 | | g r r |
| 7 | G 1 | – | W 2 | | |
| 8 | G 1 | R 3 | W 2 | | correct. |
| 9 | G 1 | – | G 2 | | |
| 10 | W 1 | R 3 | G 2 | | r r g |
| 11 | W 1 | – | R 2 | | r r |

## FIFTH NIGHT—FEBRUARY 4TH.

The weather throughout was clear. On this night the distance between the seaward and middle lamps (Nos. 1 and 3) was reduced to 10 feet, the landward lamp remaining 20 feet from the middle.

OBSERVER No. 1.

Distance 3,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | | correct. |
| 2 | W 1 | – | R 2 | | g r |
| 3 | G 1 | – | R 2 | | |
| 4 | R 1 | – | R 2 | | |
| 5 | G 1 | W 3 | R 2 | | |
| 6 | W 1 | R 3 | G 2 | | correct. |
| 7 | R 1 | W 3 | G 2 | | |
| 8 | G 1 | – | G 2 | | |
| 9 | R 1 | G 3 | G 2 | | |
| 10 | G 1 | R 3 | W 2 | | r w w |
| 11 | G 1 | – | W 2 | | g r |

Distance 2,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | | correct. |
| 2 | R 1 | W 3 | G 2 | | |
| 3 | W 1 | R 3 | G 2 | | |
| 4 | G 1 | – | W 2 | | |
| 5 | W 1 | – | R 2 | | g r |
| 6 | G 1 | W 3 | R 2 | | correct.* |
| 7 | G 1 | – | G 2 | | |
| 8 | R 1 | – | R 2 | | correct. |
| 9 | G 1 | – | R 2 | | |
| 10 | R 1 | G 3 | G 2 | | |
| 11 | G 1 | R 3 | W 2 | | g w w |

* Second attempt.

Distance 1,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | | correct. |
| 2 | R 1 | – | R 2 | | |
| 3 | R 1 | W 3 | G 2 | | |
| 4 | R 1 | G 3 | G 2 | | |
| 5 | G 1 | – | R 2 | | |
| 6 | G 1 | W 3 | R 2 | | |
| 7 | G 1 | – | W 2 | | |
| 8 | G 1 | R 3 | W 2 | | |
| 9 | G 1 | – | G 2 | | |
| 10 | W 1 | R 3 | G 2 | | |
| 11 | W 1 | – | R 2 | | |

OBSERVER No. 2.

Distance 3,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | | r r w |
| 2 | W 1 | – | R 2 | | |
| 3 | G 1 | – | R 2 | | correct. |
| 4 | R 1 | – | R 2 | | |
| 5 | G 1 | W 3 | R 2 | | r w g |
| 6 | W 1 | R 3 | G 2 | | r r g |
| 7 | R 1 | W 3 | G 2 | | correct. |
| 8 | G 1 | – | R 2 | | |
| 9 | R 1 | G 3 | G 2 | | g w r |
| 10 | G 1 | R 3 | W 2 | | r r w |
| 11 | G 1 | – | W 2 | | correct. |



Distance 2,000 yards.

| Observation. | Lights shown. | | | | Report. |
|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | | correct. |
| 2 | R 1 | W 3 | G 2 | | |
| 3 | W 1 | R 3 | G 2 | | w w g |
| 4 | G 1 | – | W 2 | | r w |
| 5 | W 1 | – | R 2 | | r r |
| 6 | G 1 | W 3 | R 2 | | g r r |
| 7 | G 1 | – | G 2 | | correct. |
| 8 | R 1 | – | R 2 | | g r |
| 9 | G 1 | – | R 2 | | r r |
| 10 | R 1 | G 3 | G 2 | | |
| 11 | G 1 | R 3 | W 2 | | correct. |

Distance 1,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | | correct. |
| 2 | R 1 | – | R 2 | | |
| 3 | R 1 | W 3 | G 2 | | |
| 4 | R 1 | G 3 | G 2 | | r g w |
| 5 | G 1 | – | R 2 | | |
| 6 | G 1 | W 3 | R 2 | | |
| 7 | G 1 | – | W 2 | | correct. |
| 8 | G 1 | R 3 | W 2 | | |
| 9 | G 1 | – | G 2 | | |
| 10 | W 1 | R 3 | G 2 | | r r g |
| 11 | W 1 | – | R 2 | | g r |

OBSERVER No. 3.

Distance 3,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | | correct. |
| 2 | W 1 | – | R 2 | | g r |
| 3 | G 1 | – | R 2 | | correct. |
| 4 | R 1 | – | R 2 | | w r |
| 5 | G 1 | W 3 | R 2 | | correct. |
| 6 | W 1 | R 3 | G 2 | | g r g |
| 7 | R 1 | W 3 | G 2 | | w r g |
| 8 | G 1 | – | G 2 | | correct. |
| 9 | R 1 | G 3 | G 2 | | |
| 10 | G 1 | R 3 | W 2 | | g w w |
| 11 | G 1 | – | W 2 | | correct. |

Distance 2,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | | correct. |
| 2 | R 1 | W 3 | G 2 | | |
| 3 | W 1 | R 3 | G 2 | | g r g |
| 4 | G 1 | – | W 2 | | correct. |
| 5 | W 1 | – | R 2 | | g r |
| 6 | G 1 | W 3 | R 2 | | correct. |
| 7 | G 1 | – | G 2 | | |
| 8 | R 1 | – | R 2 | | g r |
| 9 | G 1 | – | R 2 | | |
| 10 | R 1 | G 3 | G 2 | | correct. |
| 11 | G 1 | R 3 | W 2 | | |

Distance 1,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | | correct. |
| 2 | R 1 | – | R 2 | | |
| 3 | R 1 | W 3 | G 2 | | |
| 4 | R 1 | G 3 | G 2 | | |
| 5 | G 1 | – | R 2 | | |
| 6 | G 1 | W 3 | R 2 | | correct. |
| 7 | G 1 | – | W 2 | | |
| 8 | G 1 | R 3 | W 2 | | |
| 9 | G 1 | – | G 2 | | |
| 10 | W 1 | R 3 | G 2 | | |
| 11 | W 1 | – | R 2 | | |

OBSERVER No. 4.

Distance 3,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | | correct. |
| 2 | G 1 | – | W 2 | | |
| 3 | G 1 | – | G 2 | | |
| 4 | R 1 | G 3 | G 2 | | w g g |
| 5 | W 1 | R 3 | G 2 | | |
| 6 | G 1 | W 3 | R 2 | | |
| 7 | G 1 | – | R 2 | | |
| 8 | R 1 | W 3 | G 2 | | correct. |
| 9 | W 1 | – | R 2 | | |
| 10 | R 1 | – | R 2 | | |
| 11 | G 1 | R 3 | W 2 | | |

Distance 2,000 yards.

| Observation. | Lights shown. | | | | Report. |
|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | | correct. |
| 2 | W 1 | R 3 | G 2 | | r r g |
| 3 | W 1 | – | R 2 | | |
| 4 | R 1 | – | R 2 | | |
| 5 | R 1 | W 3 | G 2 | | |
| 6 | R 1 | G 3 | G 2 | | |
| 7 | G 1 | R 3 | W 2 | | correct. |
| 8 | G 1 | – | R 2 | | |
| 9 | G 1 | – | G 2 | | |
| 10 | G 1 | – | W 2 | | |
| 11 | G 1 | W 3 | R 2 | | |

Distance 1,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | | correct. |
| 2 | G 1 | – | R 2 | | |
| 3 | W 1 | R 3 | G 2 | | |
| 4 | R 1 | – | R 2 | | |
| 5 | G 1 | R 3 | W 2 | | |
| 6 | G 1 | – | W 2 | | correct. |
| 7 | G 1 | W 3 | R 2 | | |
| 8 | W 1 | – | R 2 | | |
| 9 | R 1 | G 3 | G 2 | | |
| 10 | G 1 | – | G 2 | | |
| 11 | R 1 | W 3 | G 2 | | |

OBSERVER No. 5.

Distance 3,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | | correct. |
| 2 | G 1 | – | W 2 | | |
| 3 | G 1 | – | G 2 | | r g |
| 4 | R 1 | G 3 | G 2 | | r r g |
| 5 | W 1 | R 3 | G 2 | | correct. |
| 6 | G 1 | W 3 | R 2 | | |
| 7 | G 1 | – | R 2 | | r r |
| 8 | R 1 | W 3 | G 2 | | r g* |
| 9 | W 1 | – | R 2 | | g r |
| 10 | R 1 | – | R 2 | | r w |
| 11 | G 1 | R 3 | W 2 | | correct. |

* Thought he saw a third light but could not name it.

Distance 2,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | | correct. |
| 2 | W 1 | R 3 | G 2 | | r r g |
| 3 | W 1 | – | R 2 | | r r |
| 4 | R 1 | – | R 2 | | r w |
| 5 | R 1 | W 3 | G 2 | | correct. |
| 6 | R 1 | G 3 | G 2 | | g g |
| 7 | G 1 | R 3 | W 2 | | correct. |
| 8 | G 1 | – | R 2 | | |
| 9 | G 1 | – | G 2 | | w g |
| 10 | G 1 | – | W 2 | | correct. |
| 11 | G 1 | W 3 | R 2 | | g g r |

Distance 1,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | | correct. |
| 2 | G 1 | – | R 2 | | |
| 3 | W 1 | R 3 | G 2 | | |
| 4 | R 1 | – | R 2 | | |
| 5 | G 1 | R 3 | W 2 | | |
| 6 | G 1 | – | W 2 | | correct. |
| 7 | G 1 | W 3 | R 2 | | |
| 8 | W 1 | – | R 2 | | |
| 9 | R 1 | G 3 | G 2 | | |
| 10 | G 1 | – | G 2 | | |
| 11 | R 1 | W 3 | G 2 | | |

OBSERVER No. 6.

Distance 3,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | | correct. |
| 2 | G 1 | – | W 2 | | |
| 3 | G 1 | – | G 2 | | g r |
| 4 | R 1 | G 3 | G 2 | | correct. |
| 5 | W 1 | R 3 | G 2 | | w g |
| 6 | G 1 | W 3 | R 2 | | g r r |
| 7 | G 1 | – | R 2 | | r r |
| 8 | R 1 | W 3 | G 2 | | g w r |
| 9 | W 1 | – | R 2 | | |
| 10 | R 1 | – | R 2 | | correct. |
| 11 | G 1 | R 3 | W 2 | | |

Distance 2,000 yards.

| Observation. | Lights shown. | | | Report. |
|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | correct. |
| 2 | W 1 | R 3 | G 2 | r r g |
| 3 | W 1 | – | R 2 | r r |
| 4 | R 1 | – | R 2 | correct. |
| 5 | R 1 | W 3 | G 2 | r g g |
| 6 | R 1 | G 3 | G 2 | correct. |
| 7 | G 1 | R 3 | W 2 | correct. |
| 8 | G 1 | – | R 2 | correct. |
| 9 | G 1 | – | G 2 | r g |
| 10 | G 1 | – | W 2 | r w |
| 11 | G 1 | W 3 | R 2 | correct. |

Distance 1,000 yards.

| | | | | |
|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | correct. |
| 2 | G 1 | – | R 2 | |
| 3 | W 1 | R 3 | G 2 | |
| 4 | R 1 | – | R 2 | |
| 5 | G 1 | R 3 | W 2 | |
| 6 | G 1 | – | W 2 | |
| 7 | G 1 | W 3 | R 2 | |
| 8 | W 1 | – | R 2 | |
| 9 | R 1 | G 3 | G 2 | |
| 10 | G 1 | – | G 2 | |
| 11 | R 1 | W 3 | G 2 | |

OBSERVER No. 7.

Distance 3,000 yards (with binoculars).

| | | | | |
|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | correct. |
| 2 | G 1 | R 3 | W 2 | |
| 3 | R 1 | W 3 | G 2 | |
| 4 | R 1 | G 3 | G 2 | |
| 5 | W 1 | R 3 | G 2 | |
| 6 | G 1 | – | R 2 | |
| 7 | G 1 | – | W 2 | |
| 8 | R 1 | – | R 2 | |
| 9 | W 1 | – | R 2 | |
| 10 | G 1 | – | G 2 | |
| 11 | G 1 | W 3 | R 2 | |

The observer could not distinguish the lights at this distance without binoculars.

Distance 2,000 yards.

| | | | | |
|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | correct. |
| 2 | G 1 | – | G 2 | |
| 3 | G 1 | – | R 2 | r r |
| 4 | G 1 | R 3 | W 2 | r r w |
| 5 | G 1 | – | W 2 | correct. |
| 6 | G 1 | W 3 | R 2 | g r |
| 7 | R 1 | – | R 2 | correct. |
| 8 | R 1 | G 3 | G 2 | w g r |
| 9 | R 1 | W 3 | G 2 | w g |
| 10 | W 1 | – | R 2 | g r |
| 11 | W 1 | R 3 | G 2 | w w g |

Distance 1,000 yards.

| | | | | |
|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | correct. |
| 2 | W 1 | G 3 | R 2 | w r |
| 3 | G 1 | G 3 | G 2 | w g |
| 4 | R 1 | – | W 2 | correct. |
| 5 | G 1 | G 3 | W 2 | g w |
| 6 | G 1 | – | G 2 | w g |
| 7 | R 1 | – | W 2 | |
| 8 | R 1 | G 3 | W 2 | correct. |
| 9 | G 1 | – | W 2 | |
| 10 | W 1 | – | G 2 | r g |
| 11 | R 1 | W 3 | G 2 | r r g |

OBSERVER No. 8.

Distance 3,000 yards.

| | | | | |
|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | correct. |
| 2 | G 1 | R 3 | W 2 | |
| 3 | R 1 | W 3 | G 2 | r g g |
| 4 | R 1 | G 3 | G 2 | r g |
| 5 | W 1 | R 3 | G 2 | |
| 6 | G 1 | – | R 2 | |
| 7 | G 1 | – | W 2 | |
| 8 | R 1 | – | R 2 | correct. |
| 9 | W 1 | – | R 2 | |
| 10 | G 1 | – | G 2 | |
| 11 | G 1 | W 3 | R 2 | |

Distance 2,000 yards.

| Observation. | Lights shown. | | | Report. |
|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | |
| 2 | G 1 | – | G 2 | |
| 3 | G 1 | – | R 2 | |
| 4 | G 1 | R 3 | W 2 | |
| 5 | G 1 | – | W 2 | |
| 6 | G 1 | W 3 | R 2 | correct. |
| 7 | R 1 | – | R 2 | |
| 8 | R 1 | G 3 | G 2 | |
| 9 | R 1 | W 3 | G 2 | |
| 10 | W 1 | – | R 2 | |
| 11 | W 1 | R 3 | G 2 | |

Distance 1,000 yards.

| | | | | |
|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | |
| 2 | W 1 | G 3 | R 2 | |
| 3 | G 1 | G 3 | G 2 | |
| 4 | R 1 | – | W 2 | |
| 5 | G 1 | G 3 | W 2 | |
| 6 | G 1 | – | G 2 | correct. |
| 7 | R 1 | – | W 2 | |
| 8 | R 1 | G 3 | W 2 | |
| 9 | G 1 | – | W 2 | |
| 10 | W 1 | – | G 2 | |
| 11 | R 1 | W 3 | G 2 | |

## SIXTH NIGHT—FEBRUARY 6TH.

There was a very slight haze but not enough to affect the visibility of the lights at 3,000 yards.

OBSERVER No. 1.

Distance 3,000 yards.

| | | | | |
|---|---|---|---|---|
| 1 | G 2 | G 3 | R 1 | w w w |
| 2 | R 2 | – | R 1 | w w |
| 3 | G 2 | – | W 1 | correct. |
| 4 | G 2 | R 3 | G 1 | g r |
| 5 | W 2 | G 3 | W 1 | w g |
| 6 | R 2 | – | W 1 | r g |
| 7 | G 2 | W 3 | W 1 | g w r |
| 8 | R 2 | G 3 | W 1 | correct. |
| 9 | W 2 | – | G 1 | g |
| 10 | R 2 | R 3 | R 1 | w r g |



Distance 2,000 yards.

| Observation. | Lights shown. | | | Report. |
|---|---|---|---|---|
| 1 | W 2 | – | G 1 | w w |
| 2 | G 2 | W 3 | W 1 | g r w |
| 3 | R 2 | G 3 | R 1 | r g w |
| 4 | W 2 | – | R 1 | correct. |
| 5 | G 2 | W 3 | G 1 | |
| 6 | R 2 | R 3 | G 1 | w r g |
| 7 | G 2 | – | W 1 | correct. |
| 8 | R 2 | – | R 1 | r w |
| 9 | W 2 | G 3 | R 1 | correct. |
| 10 | R 2 | R 3 | R 1 | |

Distance 1,000 yards.

| | | | | |
|---|---|---|---|---|
| 1 | R 2 | – | W 1 | |
| 2 | W 2 | – | G 1 | |
| 3 | R 2 | – | R 1 | |
| 4 | G 2 | – | W 1 | correct. |
| 5 | G 2 | W 3 | R 1 | |
| 6 | R 2 | G 3 | R 1 | |
| 7 | W 2 | W 3 | R 1 | w w w |
| 8 | W 2 | G 3 | W 1 | w g r |
| 9 | G 2 | G 3 | W 1 | g g r |
| 10 | R 2 | R 3 | R 1 | correct. |

OBSERVER No. 2.

Distance 3,000 yards.

| | | | | |
|---|---|---|---|---|
| 1 | G 2 | G 3 | R 1 | g g w |
| 2 | R 2 | – | R 1 | r g |
| 3 | G 2 | – | W 1 | g g |
| 4 | G 2 | R 3 | G 1 | g r w |
| 5 | W 2 | G 3 | W 1 | w r g |
| 6 | R 2 | – | W 1 | r g |
| 7 | G 2 | W 3 | W 1 | g r r |
| 8 | R 2 | G 3 | W 1 | w r g |
| 9 | W 2 | – | G 1 | g r |
| 10 | R 2 | R 3 | R 1 | w w r |

Distance 3,000 yards (with telescope).

| | | | | |
|---|---|---|---|---|
| 1 | W 2 | R 3 | W 1 | w r g |
| 2 | G 2 | W 3 | G 1 | g r g |
| 3 | W 2 | – | W 1 | w g |
| 4 | R 2 | – | G 1 | correct. |
| 5 | G 2 | – | R 1 | w r |
| 6 | R 2 | G 3 | G 1 | r g w |
| 7 | W 2 | R 3 | G 1 | correct. |
| 8 | G 2 | – | W 1 | g g |
| 9 | G 2 | G 3 | G 1 | w r r |
| 10 | R 2 | R 3 | R 1 | correct. |

Distance 2,000 yards.

| | | | | |
|---|---|---|---|---|
| 1 | W 2 | – | G 1 | w r |
| 2 | G 2 | W 3 | W 1 | correct. |
| 3 | R 2 | G 3 | R 1 | r w g |
| 4 | W 2 | – | R 1 | correct. |
| 5 | G 2 | W 3 | G 1 | g w r |
| 6 | R 2 | R 3 | G 1 | r w g |
| 7 | G 2 | – | W 1 | g r |
| 8 | R 2 | – | R 1 | r g |
| 9 | W 2 | G 3 | R 1 | w g g |
| 10 | R 2 | R 3 | R 1 | correct. |

Distance 1,000 yards.

| | | | | |
|---|---|---|---|---|
| 1 | R 2 | – | W 1 | |
| 2 | W 2 | – | G 1 | correct. |
| 3 | R 2 | – | R 1 | |
| 4 | G 2 | – | W 1 | g r |
| 5 | G 2 | W 3 | R 1 | |
| 6 | R 2 | G 3 | R 1 | correct. |
| 7 | W 2 | W 3 | R 1 | |
| 8 | W 2 | G 3 | W 1 | w g r |
| 9 | G 2 | G 3 | W 1 | g g r |
| 10 | R 2 | R 3 | R 1 | correct. |

OBSERVER No. 3.

Distance 3,000 yards.

| Observation. | Lights shown. | | | Report. |
|---|---|---|---|---|
| 1 | G 2 | G 3 | R 1 | correct. |
| 2 | R 2 | – | R 1 | w r |
| 3 | G 2 | – | W 1 | w g |
| 4 | G 2 | R 3 | G 1 | correct. |
| 5 | W 2 | G 3 | W 1 | w g r |
| 6 | R 2 | – | W 1 | r r |
| 7 | G 2 | W 3 | W 1 | g w r |
| 8 | R 2 | G 3 | W 1 | r w |
| 9 | W 2 | – | G 1 | |
| 10 | R 2 | R 3 | R 1 | correct. |

Distance 2,000 yards.

| | | | | |
|---|---|---|---|---|
| 1 | W 2 | – | G 1 | |
| 2 | G 2 | W 3 | W 1 | |
| 3 | R 2 | G 3 | R 1 | correct. |
| 4 | W 2 | – | R 1 | |
| 5 | G 2 | W 3 | G 1 | g w r |
| 6 | R 2 | R 3 | G 1 | correct. |
| 7 | G 2 | – | W 1 | g r |
| 8 | R 2 | – | R 1 | w r |
| 9 | W 2 | G 3 | R 1 | |
| 10 | R 2 | R 3 | R 1 | correct. |

Distance 1,000 yards.

| | | | | |
|---|---|---|---|---|
| 1 | R 2 | – | W 1 | |
| 2 | W 2 | – | G 1 | correct. |
| 3 | R 2 | – | R 1 | |
| 4 | G 2 | – | W 1 | w r |
| 5 | G 2 | W 3 | R 1 | |
| 6 | R 2 | G 3 | R 1 | correct. |
| 7 | W 2 | W 3 | R 1 | |
| 8 | W 2 | G 3 | W 1 | w g r |
| 9 | G 2 | G 3 | W 1 | g g r |
| 10 | R 2 | R 3 | R 1 | correct. |

OBSERVER No. 4.

Distance 3,000 yards.

| | | | | |
|---|---|---|---|---|
| 1 | W 2 | W 3 | R 1 | correct. |
| 2 | R 2 | – | G 1 | |
| 3 | G 2 | G 3 | R 1 | g r |
| 4 | G 2 | – | W 1 | correct. |
| 5 | G 2 | R 3 | G 1 | |
| 6 | R 2 | – | W 1 | r g |
| 7 | W 2 | R 3 | W 1 | w r g |
| 8 | G 2 | – | G 1 | correct. |
| 9 | W 2 | G 3 | W 1 | w g* |
| 10 | R 2 | R 3 | R 1 | correct. |

* Second attempt.

Distance 2,000 yards.

| | | | | |
|---|---|---|---|---|
| 1 | R 2 | – | W 1 | |
| 2 | W 2 | – | G 1 | |
| 3 | R 2 | – | R 1 | |
| 4 | G 2 | – | W 1 | |
| 5 | G 2 | W 3 | R 1 | |
| 6 | R 2 | G 3 | R 1 | correct |
| 7 | W 2 | W 3 | R 1 | |
| 8 | W 2 | G 3 | W 1 | |
| 9 | G 2 | G 3 | W 1 | |
| 10 | R 2 | R 3 | R 1 | |

OBSERVER No. 5.

Distance 3,000 yards.

| | | | | |
|---|---|---|---|---|
| 1 | W 2 | W 3 | R 1 | w g g |
| 2 | R 2 | – | G 1 | correct. |
| 3 | G 2 | G 3 | R 1 | r g |
| 4 | G 2 | – | W 1 | g g |
| 5 | G 2 | R 3 | G 1 | r r g |
| 6 | R 2 | – | W 1 | r g |
| 7 | W 2 | R 3 | W 1 | w r g |
| 8 | G 2 | – | G 1 | g r |
| 9 | W 2 | G 3 | W 1 | w r g |
| 10 | R 2 | R 3 | R 1 | r g g |

Distance 2,000 yards.

| Observation. | Lights shown. | Report. |
|---|---|---|
| 1 | R 2 – W 1 | correct. |
| 2 | W 2 – G 1 | |
| 3 | R 2 – R 1 | |
| 4 | G 2 – W 1 | g r |
| 5 | G 2 W 3 R 1 | correct. |
| 6 | R 2 G 3 R 1 | |
| 7 | W 2 W 3 R 1 | |
| 8 | W 2 G 3 W 1 | w g r |
| 9 | G 2 G 3 W 1 | g g g |
| 10 | R 2 R 3 R 1 | correct. |

Distance 1,000 yards.

| | | |
|---|---|---|
| 1 | W 2 – G 1 | w w |
| 2 | G 2 W 3 W 1 | correct. |
| 3 | R 2 G 3 R 1 | |
| 4 | W 2 – R 1 | |
| 5 | G 2 W 3 G 1 | g w w |
| 6 | R 2 R 3 G 1 | correct. |
| 7 | G 2 – W 1 | |
| 8 | R 2 – R 1 | |
| 9 | W 2 G 3 R 1 | |
| 10 | R 2 R 3 R 1 | |

OBSERVER No. 6.

Distance 3,000 yards.

| | | |
|---|---|---|
| 1 | W 2 W 3 R 1 | w w w |
| 2 | R 2 – G 1 | correct. |
| 3 | G 2 G 3 R 1 | w g g |
| 4 | G 2 – W 1 | g g w |
| 5 | G 2 R 3 G 1 | r g w |
| 6 | R 2 – W 1 | w g |
| 7 | W 2 R 3 W 1 | w g g |
| 8 | G 2 – G 1 | correct. |
| 9 | W 2 G 3 W 1 | w r g |
| 10 | R 2 R 3 R 1 | w r g |

Distance 2,000 yards.

| | | |
|---|---|---|
| 1 | R 2 – W 1 | correct. |
| 2 | W 2 – G 1 | |
| 3 | R 2 – R 1 | |
| 4 | G 2 – W 1 | |
| 5 | G 2 W 3 R 1 | |
| 6 | R 2 R 3 R 1 | r r r |
| 7 | W 2 W 3 R 1 | w g r |
| 8 | W 2 G 3 W 1 | w g g |
| 9 | G 2 G 3 W 1 | correct. |
| 10 | R 2 R 3 R 1 | |

Distance 1,000 yards.

| | | |
|---|---|---|
| 1 | W 2 – G 1 | w w |
| 2 | G 2 W 3 W 1 | |
| 3 | R 2 G 3 R 1 | correct. |
| 4 | W 2 – R 1 | |
| 5 | G 2 W 3 G 1 | |
| 6 | R 2 R 3 G 1 | |
| 7 | G 2 – W 1 | |
| 8 | R 2 – R 1 | |
| 9 | W 2 G 3 R 1 | |
| 10 | R 2 R 3 R 1 | |

OBSERVER No. 7.

Distance 2,000 yards.

| | | |
|---|---|---|
| 1 | G 2 W 3 G 1 | w w w |
| 2 | W 2 – R 1 | correct. |
| 3 | R 2 G 3 G 1 | r g |
| 4 | G 2 – W 1 | correct. |
| 5 | W 2 W 3 W 1 | g w r |
| 6 | R 2 W 3 G 1 | r w |
| 7 | G 2 – G 1 | correct. |
| 8 | G 2 R 3 W 1 | g w |
| 9 | W 2 – G 1 | correct. |
| 10 | R 2 R 3 R 1 | r r |

Distance 1,000 yards.

| Observation. | Lights shown. | Report. |
|---|---|---|
| 1 | W 2 R 3 W 1 | w r r |
| 2 | G 2 W 3 G 1 | correct. |
| 3 | W 2 – W 1 | w g |
| 4 | R 2 – G 1 | correct. |
| 5 | G 2 – R 1 | |
| 6 | R 2 G 3 G 1 | r g |
| 7 | W 2 R 3 G 1 | w r |
| 8 | G 2 – W 1 | correct. |
| 9 | G 2 G 3 G 1 | g g |
| 10 | R 2 R 3 R 1 | correct. |

Distance 2,000 yards.

| | | |
|---|---|---|
| 1 | G 2 W 3 G 1 | correct. |
| 2 | W 2 – R 1 | |
| 3 | R 2 G 3 G 1 | |
| 4 | G 2 – W 1 | |
| 5 | W 2 W 3 W 1 | |
| 6 | R 2 W 3 G 1 | |
| 7 | G 2 – G 1 | |
| 8 | G 2 R 3 W 1 | |
| 9 | W 2 – G 1 | |
| 10 | R 2 R 3 R 1 | |

OBSERVER No. 9.

Distance 3,000 yards.

| | | |
|---|---|---|
| 1 | W 2 R 3 W 1 | w w |
| 2 | G 2 W 3 G 1 | w |
| 3 | W 2 – W 1 | w g |
| 4 | R 2 – G 1 | r |
| 5 | G 2 – R 1 | r |
| 6 | R 2 G 3 G 1 | r |
| 7 | W 2 R 3 G 1 | w r |
| 8 | G 2 – W 1 | – |
| 9 | G 2 G 3 G 1 | – |
| 10 | R 2 R 3 R 1 | correct. |

Distance 2,000 yards.

| | | |
|---|---|---|
| 1 | G 2 W 3 G 1 | correct. |
| 2 | W 2 – R 1 | r r |
| 3 | R 2 G 3 G 1 | r |
| 4 | G 2 – W 1 | g r |
| 5 | W 2 W 3 W 1 | correct. |
| 6 | R 2 W 3 G 1 | r r |
| 7 | G 2 – G 1 | correct. |
| 8 | G 2 R 3 W 1 | r r |
| 9 | W 2 – G 1 | w |
| 10 | R 2 R 3 R 1 | correct. |

Distance 1,000 yards.

| | | |
|---|---|---|
| 1 | W 2 R 3 W 1 | |
| 2 | G 2 W 3 G 1 | |
| 3 | W 2 – W 1 | |
| 4 | R 2 – G 1 | |
| 5 | G 2 – R 1 | |
| 6 | R 2 G 3 G 1 | correct. |
| 7 | W 2 R 3 G 1 | |
| 8 | G 2 – W 1 | |
| 9 | G 2 G 3 G 1 | |
| 10 | R 2 R 3 R 1 | |



SEVENTH NIGHT—FEBRUARY 7TH.

There was a haze at 3,000 yards on this night sufficient to make the detection of the lights at that distance difficult to the normal eye. The lights could be seen without difficulty at the nearer distances, the haze gradually clearing away.

OBSERVER No. 1.

Distance 2,500 yards.

| Observation | Lights shown. | Report. |
|---|---|---|
| 1 | G 3 G 2 R 1 | correct. |
| 2 | R 3 – R 1 | |
| 3 | G 3 – W 1 | w |
| 4 | G 3 R 2 G 1 | g r r |
| 5 | R 3 G 2 W 1 | correct. |
| 6 | R 3 – W 1 | r g |
| 7 | G 3 W 2 W 1 | r w g |
| 8 | R 3 G 2 W 1 | |
| 9 | W 3 – G 1 | correct. |
| 10 | R 3 R 2 R 1 | |

Distance 1,500 yards.

| | | |
|---|---|---|
| 1 | R 3 – W 1 | |
| 2 | W 3 – G 1 | |
| 3 | R 3 – R 1 | |
| 4 | G 3 – W 1 | |
| 5 | G 3 W 2 R 1 | correct. |
| 6 | R 3 G 2 R 1 | |
| 7 | W 3 W 2 R 1 | |
| 8 | W 3 G 2 W 1 | |
| 9 | G 3 G 2 W 1 | |
| 10 | R 3 R 2 R 1 | |

Distance 500 yards.

| | | |
|---|---|---|
| 1 | G 3 W 2 G 1 | |
| 2 | W 3 – R 1 | |
| 3 | R 3 G 2 G 1 | |
| 4 | G 3 – W 1 | |
| 5 | W 3 W 2 W 1 | correct. |
| 6 | R 3 W 2 G 1 | |
| 7 | G 3 – G 1 | |
| 8 | G 3 R 2 W 1 | |
| 9 | W 3 – G 1 | |
| 10 | R 3 R 2 R 1 | |

OBSERVER No. 3.

Distance 2,500 yards.

| | | |
|---|---|---|
| 1 | G 3 G 2 R 1 | correct. |
| 2 | R 3 – R 1 | |
| 3 | G 3 – W 1 | g r |
| 4 | G 3 R 2 G 1 | correct. |
| 5 | R 3 G 2 W 1 | |
| 6 | R 3 – W 1 | r g |
| 7 | G 3 W 2 W 1 | g w r |
| 8 | R 3 G 2 W 1 | r g g |
| 9 | W 3 – G 1 | correct. |
| 10 | R 3 R 2 R 1 | |

Distance 1,500 yards.

| | | |
|---|---|---|
| 1 | R 3 – W 1 | w w |
| 2 | W 3 – G 1 | g g |
| 3 | R 3 – R 1 | |
| 4 | G 3 – W 1 | correct. |
| 5 | G 3 W 2 R 1 | |
| 6 | R 3 G 2 R 1 | |
| 7 | W 3 W 2 R 1 | g w r |
| 8 | W 3 G 2 W 1 | |
| 9 | G 3 G 2 W 1 | correct. |
| 10 | R 3 R 2 R 1 | |

Distance 1,500 yards (with binoculars).

| | | |
|---|---|---|
| 1 | W 3 R 2 W 1 | correct. |
| 2 | G 3 W 2 G 1 | |
| 3 | W 3 – W 1 | g g |
| 4 | R 3 – G 1 | correct. |
| 5 | G 3 – R 1 | |
| 6 | R 3 G 2 G 1 | r w g |
| 7 | W 3 R 2 G 1 | correct. |
| 8 | G 3 – W 1 | |
| 9 | G 3 G 2 G 1 | g w g |
| 10 | R 3 R 2 R 1 | correct. |

Distance 500 yards.

| Observation. | Lights shown. | Report. |
|---|---|---|
| 1 | G 3 W 2 G 1 | |
| 2 | W 3 – R 1 | |
| 3 | R 3 G 2 G 1 | |
| 4 | G 3 – W 1 | |
| 5 | W 3 W 2 W 1 | correct. |
| 6 | R 3 W 2 G 1 | |
| 7 | G 3 – G 1 | |
| 8 | G 3 R 2 W 1 | |
| 9 | W 3 – G 1 | |
| 10 | R 3 R 2 R 1 | |

OBSERVER No. 4.

Distance 2,500 yards.

| | | |
|---|---|---|
| 1 | G 3 G 2 R 1 | correct. |
| 2 | R 3 – R 1 | |
| 3 | G 3 – W 1 | |
| 4 | G 3 R 2 G 1 | r g |
| 5 | R 3 G 2 W 1 | correct. |
| 6 | R 3 – W 1 | |
| 7 | G 3 W 2 W 1 | w w |
| 8 | R 3 G 2 W 1 | correct. |
| 9 | W 3 – G 1 | |
| 10 | R 3 R 2 R 1 | |

Distance 1,500 yards.

| | | |
|---|---|---|
| 1 | R 3 – W 1 | correct. |
| 2 | W 3 – G 1 | |
| 3 | R 3 – R 1 | |
| 4 | G 3 – W 1 | |
| 5 | G 3 W 2 R 1 | correct. |
| 6 | R 3 G 2 R 1 | |
| 7 | W 3 W 2 R 1 | |
| 8 | W 3 G 2 W 1 | |
| 9 | G 3 G 2 W 1 | |
| 10 | R 3 R 2 R 1 | |

OBSERVER No. 5.

Distance 2,500 yards.

| | | |
|---|---|---|
| 1 | W 3 W 2 R 1 | correct. |
| 2 | R 3 – G 1 | w g |
| 3 | G 3 G 2 R 1 | correct.* |
| 4 | G 3 – W 1 | g g |
| 5 | G 3 R 2 G 1 | r r g |
| 6 | R 3 – W 1 | r r |
| 7 | W 3 R 2 W 1 | w r g |
| 8 | G 3 – G 1 | correct. |
| 9 | W 3 G 2 W 1 | g g g |
| 10 | R 3 R 2 R 1 | correct. |

* Second attempt.

Distance 1,500 yards.

| | | |
|---|---|---|
| 1 | W 3 R 2 W 1 | correct. |
| 2 | G 3 W 2 G 1 | |
| 3 | W 3 – W 1 | correct.* |
| 4 | R 3 – G 1 | |
| 5 | G 3 – R 1 | |
| 6 | R 3 G 2 G 1 | correct. |
| 7 | W 3 R 2 G 1 | |
| 8 | G 3 – W 1 | |
| 9 | G 3 G 2 G 1 | correct.* |
| 10 | R 3 R 2 R 1 | correct. |

Distance 500 yards.

| | | |
|---|---|---|
| 1 | G 3 W 2 G 1 | correct*. |
| 2 | W 3 – R 1 | correct. |
| 3 | R 3 G 2 G 1 | r g w |
| 4 | G 3 – W 1 | correct. |
| 5 | W 3 W 2 W 1 | r w w |
| 6 | R 3 W 2 G 1 | correct. |
| 7 | G 3 – G 1 | g w |
| 8 | G 3 R 2 W 1 | |
| 9 | W 3 – G 1 | correct. |
| 10 | R 3 R 2 R 1 | |

* Second attempt.

### Observer No. 6.

**Distance 2,500 yards.**

| Observation. | Lights shown. | Report. |
|---|---|---|
| 1 | W 3 W 2 R 1 | correct. |
| 2 | R 3 – G 1 | correct. |
| 3 | G 3 G 2 R 1 | g g w |
| 4 | G 3 – W 1 | correct. |
| 5 | G 3 R 2 G 1 | r r g |
| 6 | R 3 – W 1 | w g |
| 7 | W 3 R 2 W 1 | w w w |
| 8 | G 3 – G 1 | correct. |
| 9 | W 3 G 2 W 1 | g g g |
| 10 | R 3 R 2 R 1 | correct. |

**Distance 1,500 yards.**

| | | |
|---|---|---|
| 1 | W 3 R 2 W 1 | w r g |
| 2 | G 3 W 2 G 1 | correct. |
| 3 | W 3 – W 1 | correct. |
| 4 | R 3 – G 1 | correct. |
| 5 | G 3 – R 1 | r r |
| 6 | R 3 G 2 G 1 | r g w |
| 7 | W 3 R 2 G 1 | correct. |
| 8 | G 3 – W 1 | correct. |
| 9 | G 3 G 2 G 1 | correct. |
| 10 | R 3 R 2 R 1 | correct. |

**Distance 500 yards.**

| | | |
|---|---|---|
| 1 | G 3 G 2 R 1 | correct. |
| 2 | R 3 – R 1 | correct. |
| 3 | G 3 – W 1 | correct. |
| 4 | G 3 R 2 G 1 | correct. |
| 5 | W 3 G 2 W 1 | correct. |
| 6 | R 3 – W 1 | correct. |
| 7 | G 3 W 2 W 1 | correct. |
| 8 | R 3 G 2 W 1 | r g r |
| 9 | W 3 – G 1 | g g |
| 10 | R 3 R 2 R 1 | correct. |

### Observer No. 7.

**Distance 1,500 yards.**

| | | |
|---|---|---|
| 1 | W 3 – G 1 | — |
| 2 | G 3 W 2 W 1 | w g |
| 3 | R 3 G 2 R 1 | w g r |
| 4 | W 3 – R 1 | r r |
| 5 | G 3 W 2 G 1 | g w |
| 6 | R 3 R 2 G 1 | r g |
| 7 | G 3 – W 1 | — |
| 8 | R 3 – R 1 | correct. |
| 9 | W 3 G 2 R 1 | g g r |
| 10 | R 3 R 2 R 1 | g r r |

**Distance 500 yards.**

| | | |
|---|---|---|
| 1 | G 3 G 2 R 1 | correct. |
| 2 | R 3 – R 1 | correct. |
| 3 | G 3 – W 1 | correct. |
| 4 | G 3 R 2 G 1 | correct. |
| 5 | W 3 G 2 W 1 | correct. |
| 6 | R 3 – W 1 | correct. |
| 7 | G 3 W 2 W 1 | correct. |
| 8 | R 3 G 2 W 1 | correct. |
| 9 | W 3 – G 1 | correct. |
| 10 | R 3 R 2 R 1 | correct. |

### Observer No. 8.

**Distance 2,500 yards.**

| | | |
|---|---|---|
| 1 | G 3 W 2 G 1 | correct. |
| 2 | W 3 – R 1 | correct.* |
| 3 | R 3 G 2 G 1 | correct. |
| 4 | G 3 – W 1 | correct. |
| 5 | W 3 W 2 W 1 | correct. |
| 6 | R 3 W 2 G 1 | correct. |
| 7 | G 3 – G 1 | g g g |
| 8 | G 3 R 2 W 1 | correct. |
| 9 | W 3 – G 1 | correct. |
| 10 | R 3 R 2 R 1 | correct. |

* Second attempt.

**Distance 1,500 yards.**

| Observation. | Lights shown. | Report. |
|---|---|---|
| 1 | W 3 – G 1 | correct. |
| 2 | G 3 W 2 W 1 | correct. |
| 3 | R 3 G 2 R 1 | correct. |
| 4 | W 3 – R 1 | correct. |
| 5 | G 3 W 2 G 1 | correct. |
| 6 | R 3 R 2 G 1 | correct. |
| 7 | G 3 – W 1 | correct. |
| 8 | R 3 – R 1 | correct. |
| 9 | W 3 G 2 R 1 | correct. |
| 10 | R 3 R 2 R 1 | correct. |

### Observer No. 9.

**Distance 2,500 yards.**

| | | |
|---|---|---|
| 1 | G 3 W 2 G 1 | w |
| 2 | W 3 – R 1 | r r |
| 3 | R 3 G 2 G 1 | r |
| 4 | G 3 – W 1 | — |
| 5 | W 3 W 2 W 1 | correct. |
| 6 | R 3 W 2 G 1 | r w |
| 7 | G 3 – G 1 | — |
| 8 | G 3 R 2 W 1 | r w |
| 9 | W 3 – G 1 | g |
| 10 | R 3 R 2 R 1 | correct. |

**Distance 1,500 yards.**

| | | |
|---|---|---|
| 1 | W 3 – G 1 | correct. |
| 2 | G 3 W 2 W 1 | correct. |
| 3 | R 3 G 2 R 1 | correct. |
| 4 | W 3 – R 1 | correct. |
| 5 | G 3 W 2 G 1 | correct. |
| 6 | R 3 R 2 G 1 | correct. |
| 7 | G 3 – W 1 | w |
| 8 | R 3 – R 1 | correct. |
| 9 | W 3 G 2 R 1 | correct. |
| 10 | R 3 R 2 R 1 | correct. |

**Distance 500 yards.**

| | | |
|---|---|---|
| 1 | G 3 G 2 R 1 | correct. |
| 2 | R 3 – R 1 | correct. |
| 3 | G 3 – W 1 | correct. |
| 4 | G 3 R 2 G 1 | correct. |
| 5 | W 3 G 2 W 1 | correct. |
| 6 | R 3 – W 1 | correct. |
| 7 | G 3 W 2 W 1 | correct. |
| 8 | R 3 G 2 W 1 | correct. |
| 9 | W 3 – G 1 | correct. |
| 10 | R 3 R 2 R 1 | correct. |

## EIGHTH NIGHT—FEBRUARY 8TH.

The weather was quite clear throughout.

### Observer No. 1.

**Distance 3,000 yards (with binoculars).**

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | correct. |
| 2 | W 1 – R 3 | correct. |
| 3 | G 1 – R 3 | correct. |
| 4 | R 1 – R 3 | correct. |
| 5 | G 1 W 2 R 3 | correct. |
| 6 | W 1 R 2 G 3 | correct. |
| 7 | R 1 W 2 G 3 | correct. |
| 8 | G 1 – G 3 | correct. |
| 9 | R 1 G 2 G 3 | correct. |
| 10 | G 1 R 2 W 3 | correct. |
| 11 | G 1 – W 3 | correct. |

**Distance 2,000 yards (with binoculars).**

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | correct. |
| 2 | R 1 W 2 G 3 | correct. |
| 3 | W 1 R 2 G 3 | correct. |
| 4 | G 1 – W 3 | correct. |
| 5 | W 1 – R 3 | correct. |
| 6 | G 1 W 2 R 3 | correct. |
| 7 | G 1 – G 3 | correct. |
| 8 | R 1 – R 3 | correct. |
| 9 | G 1 – R 3 | correct. |
| 10 | R 1 G 2 G 3 | correct. |
| 11 | G 1 R 2 W 3 | correct. |



**Distance 1,000 yards.**

| Observation. | Lights shown. | Report. |
|---|---|---|
| 1 | W 1 W 2 W 3 | correct. |
| 2 | G 1 – R 3 | correct. |
| 3 | W 1 R 2 G 3 | correct. |
| 4 | R 1 – R 3 | correct. |
| 5 | G 1 R 2 W 3 | correct. |
| 6 | G 1 – W 3 | correct. |
| 7 | G 1 W 2 R 3 | correct. |
| 8 | W 1 – R 3 | correct. |
| 9 | R 1 G 2 G 3 | correct. |
| 10 | G 1 – G 3 | correct. |
| 11 | R 1 W 2 G 3 | correct. |

### Observer No. 3.

**Distance 3,000 yards.**

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | r w g |
| 2 | W 1 – R 3 | g r |
| 3 | G 1 – R 3 | correct. |
| 4 | R 1 – R 3 | correct. |
| 5 | G 1 W 2 R 3 | correct. |
| 6 | W 1 R 2 G 3 | g r g |
| 7 | R 1 W 2 G 3 | correct. |
| 8 | G 1 – G 3 | correct. |
| 9 | R 1 G 2 G 3 | correct. |
| 10 | G 1 R 2 W 3 | g w w* |
| 11 | G 1 – W 3 | correct. |

* Second attempt.

**Distance 2,000 yards.**

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | w w g |
| 2 | R 1 W 2 G 3 | correct. |
| 3 | W 1 R 2 G 3 | correct. |
| 4 | G 1 – W 3 | correct. |
| 5 | W 1 – R 3 | g r |
| 6 | G 1 W 2 R 3 | correct. |
| 7 | G 1 – G 3 | correct. |
| 8 | R 1 – R 3 | correct. |
| 9 | G 1 – R 3 | correct. |
| 10 | R 1 G 2 G 3 | r w g |
| 11 | G 1 R 2 W 3 | correct. |

**Distance 1,000 yards.**

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | correct. |
| 2 | G 1 – R 3 | correct. |
| 3 | W 1 R 2 G 3 | correct. |
| 4 | R 1 – R 3 | correct. |
| 5 | G 1 R 2 W 3 | correct. |
| 6 | G 1 – W 3 | correct. |
| 7 | G 1 W 2 R 3 | correct. |
| 8 | W 1 – R 3 | correct. |
| 9 | R 1 G 2 G 3 | correct. |
| 10 | G 1 – G 3 | correct. |
| 11 | R 1 W 2 G 3 | correct. |

### Observer No. 4.

**Distance, 3,000 yards.**

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | correct. |
| 2 | W 1 – R 3 | correct. |
| 3 | G 1 – R 3 | correct. |
| 4 | R 1 – R 3 | correct. |
| 5 | G 1 W 2 R 3 | correct. |
| 6 | W 1 R 2 G 3 | correct. |
| 7 | R 1 W 2 G 3 | correct. |
| 8 | G 1 – G 3 | correct. |
| 9 | R 1 G 2 G 3 | correct. |
| 10 | G 1 R 2 W 3 | correct. |
| 11 | G 1 – W 3 | correct. |

**Distance, 2,000 yards.**

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | w w g |
| 2 | R 1 W 2 G 3 | correct. |
| 3 | W 1 R 2 G 3 | correct. |
| 4 | G 1 – W 3 | correct. |
| 5 | W 1 – R 3 | correct. |
| 6 | G 1 W 2 R 3 | correct. |
| 7 | G 1 – G 3 | correct. |
| 8 | R 1 – R 3 | correct. |
| 9 | G 1 – R 3 | correct. |
| 10 | R 1 G 2 G 3 | correct. |
| 11 | G 1 R 2 W 3 | correct. |

### Observer No. 5.

**Distance 3,000 yards (with binoculars).**

| Observation. | Lights shown. | Report. |
|---|---|---|
| 1 | W 1 W 2 W 3 | correct. |
| 2 | R 1 – R 3 | correct. |
| 3 | R 1 W 2 G 3 | correct. |
| 4 | R 1 G 2 G 3 | correct. |
| 5 | G 1 – R 3 | correct. |
| 6 | G 1 W 2 R 3 | correct. |
| 7 | G 1 – W 3 | correct. |
| 8 | G 1 R 2 W 3 | correct. |
| 9 | G 1 – G 3 | correct. |
| 10 | W 1 R 2 G 3 | correct. |
| 11 | W 1 – R 3 | correct. |

**Distance 2,000 yards.**

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | correct. |
| 2 | G 1 R 2 W 3 | correct. |
| 3 | R 1 W 2 G 3 | correct. |
| 4 | R 1 G 2 G 3 | correct. |
| 5 | W 1 R 2 G 3 | correct. |
| 6 | G 1 – R 3 | correct. |
| 7 | G 1 – W 3 | correct. |
| 8 | R 1 – R 3 | correct. |
| 9 | W 1 – R 3 | g r |
| 10 | G 1 – G 3 | correct. |
| 11 | G 1 W 2 R 3 | correct. |

**Distance 1,000 yards.**

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | correct. |
| 2 | G 1 – R 3 | correct. |
| 3 | W 1 R 2 G 3 | correct. |
| 4 | R 1 – R 3 | correct. |
| 5 | G 1 R 2 W 3 | correct. |
| 6 | G 1 – W 3 | correct. |
| 7 | G 1 W 2 R 3 | correct. |
| 8 | W 1 – R 3 | correct. |
| 9 | R 1 G 2 G 3 | correct. |
| 10 | G 1 – G 3 | correct. |
| 11 | R 1 W 2 G 3 | correct. |

### Observer No. 6.

**Distance 3,000 yards.**

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | correct. |
| 2 | R 1 – R 3 | r w |
| 3 | R 1 W 2 G 3 | g w r |
| 4 | R 1 G 2 G 3 | correct. |
| 5 | G 1 – R 3 | correct. |
| 6 | G 1 W 2 R 3 | correct. |
| 7 | G 1 – W 3 | correct. |
| 8 | G 1 R 2 W 3 | correct. |
| 9 | G 1 – G 3 | correct. |
| 10 | W 1 R 2 G 3 | r r r |
| 11 | W 1 – R 3 | g w |

**Distance 2,000 yards (with binoculars).**

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | correct. |
| 2 | G 1 R 2 W 3 | correct. |
| 3 | R 1 W 2 G 3 | correct. |
| 4 | R 1 G 2 G 3 | correct. |
| 5 | W 1 R 2 G 3 | g r g |
| 6 | G 1 – R 3 | correct. |
| 7 | G 1 – W 3 | correct. |
| 8 | R 1 – R 3 | correct. |
| 9 | W 1 – R 3 | correct.* |
| 10 | G 1 – G 3 | correct. |
| 11 | G 1 W 2 R 3 | correct. |

* Second attempt.

**Distance 1,000 yards.**

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | correct. |
| 2 | W 1 G 2 R 3 | g g r |
| 3 | G 1 G 2 G 3 | correct. |
| 4 | R 1 – W 3 | correct. |
| 5 | G 1 G 2 W 3 | correct. |
| 6 | G 1 – G 3 | correct. |
| 7 | R 1 – W 3 | correct. |
| 8 | R 1 G 2 W 3 | correct. |
| 9 | G 1 – W 3 | correct. |
| 10 | W 1 – G 3 | g g |
| 11 | R 1 W 2 G 3 | correct. |

### Observer No. 7.

Distance 2,000 yards.

| Observation. | Lights shown. | Report. |
|---|---|---|
| 1 | W 1 W 2 W 3 | correct. |
| 2 | G 1 R 2 W 3 | r r |
| 3 | R 1 W 2 G 3 | w w |
| 4 | R 1 G 2 G 3 | w g |
| 5 | W 1 R 2 G 3 | g r |
| 6 | G 1 – R 3 | g r r |
| 7 | G 1 – W 3 | correct. |
| 8 | R 1 – R 3 | r w |
| 9 | W 1 – R 3 | g r |
| 10 | G 1 – G 3 | g w |
| 11 | G 1 W 2 R 3 | w w |

Distance 1,000 yards.

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | } correct. |
| 2 | W 1 G 2 R 3 | |
| 3 | G 1 G 2 G 3 | |
| 4 | R 1 – W 3 | |
| 5 | G 1 G 2 W 3 | w g w |
| 6 | G 1 – G 3 | } correct. |
| 7 | R 1 – W 3 | |
| 8 | R 1 G 2 W 3 | |
| 9 | G 1 – W 3 | |
| 10 | W 1 – G 3 | |
| 11 | R 1 W 2 G 3 | |

### Observer No. 8.

Distance 3,000 yards.

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | } correct. |
| 2 | R 1 – R 3 | |
| 3 | R 1 W 2 G 3 | |
| 4 | R 1 G 2 G 3 | |
| 5 | G 1 – R 3 | |
| 6 | G 1 W 2 R 3 | |
| 7 | G 1 – W 3 | |
| 8 | G 1 R 2 W 3 | |
| 9 | G 1 – G 3 | |
| 10 | W 1 R 2 G 3 | |
| 11 | W 1 – R 3 | |

Distance 2,000 yards.

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | } correct. |
| 2 | G 1 – G 3 | |
| 3 | G 1 – R 3 | |
| 4 | G 1 R 2 W 3 | |
| 5 | G 1 – W 3 | |
| 6 | G 1 W 2 R 3 | |
| 7 | R 1 – R 3 | |
| 8 | R 1 G 2 G 3 | |
| 9 | R 1 W 2 G 3 | |
| 10 | W 1 – R 3 | |
| 11 | W 1 R 2 G 3 | |

### Observer No. 9.

Distance 2,000 yards.

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | r w r |
| 2 | G 1 – G 3 | – |
| 3 | G 1 – R 3 | r |
| 4 | G 1 R 2 W 3 | correct |
| 5 | G 1 – W 3 | w |
| 6 | G 1 W 2 R 3 | w r |
| 7 | R 1 – R 3 | } correct. |
| 8 | R 1 G 2 G 3 | |
| 9 | R 1 W 2 G 3 | r w |
| 10 | W 1 – R 3 | r r |
| 11 | W 1 R 2 G 3 | w r |

Distance 1,000 yards.

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | correct. |
| 2 | W 1 G 2 R 3 | r g g |
| 3 | G 1 G 2 G 3 | } correct. |
| 4 | R 1 – W 3 | |
| 5 | G 1 G 2 W 3 | |
| 6 | G 1 – G 3 | |
| 7 | R 1 – W 3 | r r |
| 8 | R 1 G 2 W 3 | } correct. |
| 9 | G 1 – W 3 | |
| 10 | W 1 – G 3 | |
| 11 | R 1 W 2 G 3 | |

## NINTH NIGHT—FEBRUARY 9TH.

The weather was quite clear throughout.

### Observer No. 1.

Distance 3,000 yards.

| Observation. | Lights shown. | Report. |
|---|---|---|
| 1 | W 1 W 2 W 3 | correct. |
| 2 | G 1 G 2 W 3 | g g g |
| 3 | R 1 – R 3 | correct.* |
| 4 | W 1 – G 3 | w |
| 5 | W 1 G 2 G 3 | g g |
| 6 | G 1 R 2 W 3 | correct. |
| 7 | R 1 W 2 G 3 | r w |
| 8 | G 1 – W 3 | correct. |
| 9 | W 1 W 2 G 3 | g w r |
| 10 | R 1 – W 3 | g r w |
| 11 | G 1 – R 3 | correct. |

* Second attempt.

Distance 2,000 yards.

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | } correct. |
| 2 | W 1 G 2 R 3 | |
| 3 | G 1 G 2 G 3 | |
| 4 | R 1 – W 3 | r r |
| 5 | G 1 G 2 W 3 | correct. |
| 6 | G 1 – G 3 | w g |
| 7 | R 1 – W 3 | } correct. |
| 8 | R 1 G 2 W 3 | |
| 9 | G 1 – W 3 | |
| 10 | W 1 – G 3 | |
| 11 | R 1 W 2 G 3 | |

Distance 1,000 yards.

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | } correct. |
| 2 | R 1 W 2 G 3 | |
| 3 | W 1 R 2 G 3 | |
| 4 | G 1 – W 3 | |
| 5 | W 1 – R 3 | |
| 6 | G 1 W 2 R 3 | g g r |
| 7 | G 1 – G 3 | } correct. |
| 8 | R 1 – R 3 | |
| 9 | G 1 – R 3 | |
| 10 | R 1 G 2 G 3 | |
| 11 | G 1 R 2 W 3 | |

### Observer No. 2.

Distance 3,000 yards.

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | w w g |
| 2 | G 1 G 2 W 3 | g g g |
| 3 | R 1 – R 3 | } correct. |
| 4 | W 1 – G 3 | |
| 5 | W 1 G 2 G 3 | w w g |
| 6 | G 1 R 2 W 3 | g w g |
| 7 | R 1 W 2 G 3 | g w r |
| 8 | G 1 – W 3 | g g |
| 9 | W 1 W 2 G 3 | g w r |
| 10 | R 1 – W 3 | g r |
| 11 | G 1 – R 3 | correct. |

Distance 2,000 yards.

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | correct. |
| 2 | W 1 G 2 R 3 | g g g |
| 3 | G 1 G 2 G 3 | r g r |
| 4 | R 1 – W 3 | r g |
| 5 | G 1 G 2 W 3 | g g r |
| 6 | G 1 – G 3 | g r |
| 7 | R 1 – W 3 | r g |
| 8 | R 1 G 2 W 3 | correct. |
| 9 | G 1 – W 3 | g g |
| 10 | W 1 – G 3 | } correct. |
| 11 | R 1 W 2 G 3 | |



Distance 1,000 yards.

| Observation. | Lights shown. | Report. |
|---|---|---|
| 1 | W 1 W 2 W 3 | correct. |
| 2 | R 1 W 2 G 3 | r r r |
| 3 | W 1 R 2 G 3 | w r w |
| 4 | G 1 – W 3 | g r |
| 5 | W 1 – R 3 | r r |
| 6 | G 1 W 2 R 3 | w r r |
| 7 | G 1 – G 3 | } correct. |
| 8 | R 1 – R 3 | |
| 9 | G 1 – R 3 | |
| 10 | R 1 G 2 G 3 | |
| 11 | G 1 R 2 W 3 | |

### Observer No. 3.

Distance 3,000 yards.

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | g w g |
| 2 | G 1 G 2 W 3 | g g r |
| 3 | R 1 – R 3 | correct. |
| 4 | W 1 – G 3 | r g |
| 5 | W 1 G 2 G 3 | r w g |
| 6 | G 1 R 2 W 3 | } correct. |
| 7 | R 1 W 2 G 3 | |
| 8 | G 1 – W 3 | g g |
| 9 | W 1 W 2 G 3 | r w g |
| 10 | R 1 – W 3 | r r |
| 11 | G 1 – R 3 | correct. |

Distance 2,000 yards.

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | } correct. |
| 2 | W 1 G 2 R 3 | |
| 3 | G 1 G 2 G 3 | |
| 4 | R 1 – W 3 | |
| 5 | G 1 G 2 W 3 | g g r |
| 6 | G 1 – G 3 | } correct. |
| 7 | R 1 – W 3 | |
| 8 | R 1 G 2 W 3 | r g g |
| 9 | G 1 – W 3 | correct. |
| 10 | W 1 – G 3 | r g |
| 11 | R 1 W 2 G 3 | correct. |

Distance 1,000 yards.

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | correct. |
| 2 | R 1 W 2 G 3 | r g g |
| 3 | W 1 R 2 G 3 | } correct. |
| 4 | G 1 – W 3 | |
| 5 | W 1 – R 3 | |
| 6 | G 1 W 2 R 3 | g g r |
| 7 | G 1 – G 3 | } correct. |
| 8 | R 1 – R 3 | |
| 9 | G 1 – R 3 | |
| 10 | R 1 G 2 G 3 | |
| 11 | G 1 R 2 W 3 | |

### Observer No. 4.

Distance 3,000 yards.

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | correct. |
| 2 | W 1 R 2 G 3 | g r g |
| 3 | W 1 – R 3 | } correct. |
| 4 | R 1 – R 3 | |
| 5 | R 1 W 2 G 3 | |
| 6 | R 1 G 2 G 3 | |
| 7 | G 1 R 2 W 3 | |
| 8 | G 1 – R 3 | |
| 9 | G 1 – G 3 | g r |
| 10 | G 1 – W 3 | } correct. |
| 11 | G 1 W 2 R 3 | |

Distance 2,000 yards.

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | } correct. |
| 2 | W 1 – R 3 | |
| 3 | G 1 – R 3 | |
| 4 | R 1 – R 3 | |
| 5 | G 1 W 2 R 3 | |
| 6 | W 1 R 2 G 3 | |
| 7 | R 1 W 2 G 3 | |
| 8 | G 1 – G 3 | |
| 9 | R 1 G 2 G 3 | |
| 10 | G 1 R 2 W 3 | |
| 11 | G 1 – W 3 | |

Distance 1,000 yards.

| Observation. | Lights shown. | Report. |
|---|---|---|
| 1 | W 1 W 2 W 3 | } correct |
| 2 | G 1 – R 3 | |
| 3 | W 1 R 2 G 3 | |
| 4 | R 1 – R 3 | |
| 5 | G 1 R 2 W 3 | |
| 6 | G 1 – W 3 | |
| 7 | G 1 W 2 R 3 | |
| 8 | W 1 – R 3 | |
| 9 | R 1 G 2 G 3 | } correct. |
| 10 | G 1 – G 3 | |
| 11 | R 1 W 2 G 3 | |

### Observer No. 5.

Distance 3,000 yards.

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | } correct. |
| 2 | W 1 R 2 G 3 | |
| 3 | W 1 – R 3 | r r |
| 4 | R 1 – R 3 | r w |
| 5 | R 1 W 2 G 3 | g w |
| 6 | R 1 G 2 G 3 | g |
| 7 | G 1 R 2 W 3 | r r r |
| 8 | G 1 – R 3 | } correct. |
| 9 | G 1 – G 3 | |
| 10 | G 1 – W 3 | r w |
| 11 | G 1 W 2 R 3 | r w g |

Distance 2,000 yards.

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | } correct. |
| 2 | W 1 – R 3 | |
| 3 | G 1 – R 3 | |
| 4 | R 1 – R 3 | |
| 5 | G 1 W 2 R 3 | |
| 6 | W 1 R 2 G 3 | |
| 7 | R 1 W 2 G 3 | |
| 8 | G 1 – G 3 | |
| 9 | R 1 G 2 G 3 | |
| 10 | G 1 R 2 W 3 | |
| 11 | G 1 – W 3 | |

Distance 1,000 yards.

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | } correct. |
| 2 | G 1 – R 3 | |
| 3 | W 1 R 2 G 3 | |
| 4 | R 1 – R 3 | |
| 5 | G 1 R 2 W 3 | |
| 6 | G 1 – W 3 | g g |
| 7 | G 1 W 2 R 3 | } correct. |
| 8 | W 1 – R 3 | |
| 9 | R 1 G 2 G 3 | |
| 10 | G 1 – G 3 | |
| 11 | R 1 W 2 G 3 | |

### Observer No. 6.

Distance 3,000 yards.

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | correct. |
| 2 | W 1 R 2 G 3 | r r |
| 3 | W 1 – R 3 | correct. |
| 4 | R 1 – R 3 | * |
| 5 | R 1 W 2 G 3 | g w r |
| 6 | R 1 G 2 G 3 | g g g |
| 7 | G 1 R 2 W 3 | r r r |
| 8 | G 1 – R 3 | } correct. |
| 9 | G 1 – G 3 | |
| 10 | G 1 – W 3 | |
| 11 | G 1 W 2 R 3 | |

* Could see two lights, but could not name them.

Distance 3,000 yards (with binoculars).

| | | |
|---|---|---|
| 1 | W 1 W 2 W 3 | } correct. |
| 2 | G 1 – W 3 | |
| 3 | G 1 – G 3 | w g |
| 4 | R 1 G 2 G 3 | r g w |
| 5 | W 1 R 2 G 3 | r r g |
| 6 | G 1 W 2 R 3 | correct. |
| 7 | G 1 – R 3 | w r |
| 8 | R 1 W 2 G 3 | } correct. |
| 9 | W 1 – R 3 | |
| 10 | R 1 – R 3 | |
| 11 | G 1 R 2 W 3 | w r w |

Distance 2,000 yards.

| Observation. | Lights shown. | | | | Report. |
|---|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | - | correct. |
| 2 | W 1 | – | R 3 | - | |
| 3 | G 1 | – | R 3 | - | |
| 4 | R 1 | – | R 3 | - | |
| 5 | G 1 | W 2 | R 3 | - | |
| 6 | W 1 | R 2 | G 3 | - | g r r |
| 7 | R 1 | W 2 | G 3 | - | correct. |
| 8 | G 1 | – | G 3 | - | |
| 9 | R 1 | G 2 | G 3 | - | |
| 10 | G 1 | R 2 | W 3 | - | r r g |
| 11 | G 1 | – | W 3 | - | correct. |

Distance 1,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | - | correct. |
| 2 | G 1 | – | R 3 | - | |
| 3 | W 1 | R 2 | G 3 | - | |
| 4 | R 1 | – | R 3 | - | r w |
| 5 | G 1 | R 2 | W 3 | - | correct. |
| 6 | G 1 | – | W 3 | - | correct. |
| 7 | G 1 | W 2 | R 3 | - | |
| 8 | W 1 | – | R 3 | - | |
| 9 | R 1 | G 2 | G 3 | - | |
| 10 | G 1 | – | G 3 | - | |
| 11 | R 1 | W 2 | G 3 | - | correct.* |

* Second attempt, but uncertain.

OBSERVER No. 7.

Distance 2,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | - | correct. |
| 2 | R 1 | – | R 3 | - | r |
| 3 | R 1 | W 2 | G 3 | - | correct. |
| 4 | R 1 | G 2 | G 3 | - | g w g |
| 5 | G 1 | – | R 3 | - | correct. |
| 6 | G 1 | W 2 | R 3 | - | correct. |
| 7 | G 1 | – | W 3 | - | g g |
| 8 | G 1 | R 2 | W 3 | - | r r |
| 9 | G 1 | – | G 3 | - | g w |
| 10 | W 1 | R 2 | G 3 | - | r w |
| 11 | W 1 | – | R 3 | - | — |

Distance 1,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | - | correct. |
| 2 | G 1 | R 2 | W 3 | - | g w |
| 3 | R 1 | W 2 | G 3 | - | correct. |
| 4 | R 1 | G 2 | G 3 | - | |
| 5 | W 1 | R 2 | G 3 | - | w g g |
| 6 | G 1 | – | R 3 | - | correct. |
| 7 | G 1 | – | W 3 | - | |
| 8 | R 1 | – | R 3 | - | |
| 9 | W 1 | – | R 3 | - | |
| 10 | G 1 | – | G 3 | - | |
| 11 | G 1 | W 2 | R 3 | - | g g r |

OBSERVER No. 8.

Distance, 3,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | - | correct. |
| 2 | G 1 | – | W 3 | - | |
| 3 | G 1 | – | G 3 | - | |
| 4 | R 1 | G 2 | G 3 | - | |
| 5 | W 1 | R 2 | G 3 | - | w r |
| 6 | G 1 | W 2 | R 3 | - | correct. |
| 7 | G 1 | – | R 3 | - | |
| 8 | R 1 | W 2 | G 3 | - | |
| 9 | W 1 | – | R 3 | - | |
| 10 | R 1 | – | R 3 | - | |
| 11 | G 1 | R 2 | W 3 | - | |

Distance, 2,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | - | correct. |
| 2 | R 1 | – | R 3 | - | |
| 3 | R 1 | W 2 | G 3 | - | |
| 4 | R 1 | G 2 | G 3 | - | |
| 5 | G 1 | – | R 3 | - | |
| 6 | G 1 | W 2 | R 3 | - | correct. |
| 7 | G 1 | – | W 3 | - | |
| 8 | G 1 | R 2 | W 3 | - | |
| 9 | G 1 | – | G 3 | - | |
| 10 | W 1 | R 2 | G 3 | - | |
| 11 | W 1 | – | R 3 | - | |

Distance, 1,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | - | correct. |
| 2 | G 1 | R 2 | W 3 | - | |
| 3 | R 1 | W 2 | G 3 | - | |
| 4 | R 1 | G 2 | G 3 | - | |
| 5 | W 1 | R 2 | G 3 | - | correct. |
| 6 | G 1 | – | R 3 | - | |
| 7 | G 1 | – | W 3 | - | |
| 8 | R 1 | – | R 3 | - | |
| 9 | W 1 | – | R 3 | - | |
| 10 | G 1 | – | G 3 | - | |
| 11 | G 1 | W 2 | R 3 | - | g g r |

Distance, 1,000 yards.

| Observation. | Lights shown. | | | | Report. |
|---|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | - | correct. |
| 2 | G 1 | R 2 | W 3 | - | |
| 3 | R 1 | W 2 | G 3 | - | |
| 4 | R 1 | G 2 | G 3 | - | |
| 5 | W 1 | R 2 | G 3 | - | |
| 6 | G 1 | – | R 3 | - | correct. |
| 7 | G 1 | – | W 3 | - | |
| 8 | R 1 | – | R 3 | - | |
| 9 | W 1 | – | R 3 | - | |
| 10 | G 1 | – | G 3 | - | |
| 11 | G 1 | W 2 | R 3 | - | |

OBSERVER No. 9.

Distance, 2,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | - | r w r |
| 2 | R 1 | – | R 3 | - | correct. |
| 3 | R 1 | W 2 | G 3 | - | r w |
| 4 | R 1 | G 2 | G 3 | - | r g |
| 5 | G 1 | – | R 3 | - | r |
| 6 | G 1 | W 2 | R 3 | - | w r |
| 7 | G 1 | – | W 3 | - | w |
| 8 | G 1 | R 2 | W 3 | - | r w |
| 9 | G 1 | – | G 3 | - | — |
| 10 | W 1 | R 2 | G 3 | - | r r |
| 11 | W 1 | – | R 3 | - | correct. |

Distance, 1,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | - | correct. |
| 2 | G 1 | R 2 | W 3 | - | |
| 3 | R 1 | W 2 | G 3 | - | |
| 4 | R 1 | G 2 | G 3 | - | |
| 5 | W 1 | R 2 | G 3 | - | |
| 6 | G 1 | – | R 3 | - | |
| 7 | G 1 | – | W 3 | - | |
| 8 | R 1 | – | R 3 | - | |
| 9 | W 1 | – | R 3 | - | |
| 10 | G 1 | – | G 3 | - | |
| 11 | G 1 | W 2 | R 3 | - | g g r |

## TENTH NIGHT—FEBRUARY 10TH.

There was a slight haze which, with the moon shining brightly within three days of being full, rendered the lights practically invisible at 3,000 yards. They could, however, be easily seen at 2,000 yards.

OBSERVER No. 1.

Distance, 2,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | - | correct. |
| 2 | G 1 | – | W 3 | - | |
| 3 | G 1 | – | G 3 | - | w g |
| 4 | R 1 | G 2 | G 3 | - | correct. |
| 5 | W 1 | R 2 | G 3 | - | |
| 6 | G 1 | W 2 | R 3 | - | |
| 7 | G 1 | – | R 3 | - | |
| 8 | R 1 | W 2 | G 3 | - | |
| 9 | W 1 | – | R 3 | - | |
| 10 | R 1 | – | R 3 | - | |
| 11 | G 1 | R 2 | W 3 | - | |

Distance, 1,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | - | correct. |
| 2 | G 1 | R 2 | W 3 | - | |
| 3 | R 1 | W 2 | G 3 | - | |
| 4 | R 1 | G 2 | G 3 | - | |
| 5 | W 1 | R 2 | G 3 | - | |
| 6 | G 1 | – | R 3 | - | correct. |
| 7 | G 1 | – | W 3 | - | |
| 8 | R 1 | – | R 3 | - | |
| 9 | W 1 | – | R 3 | - | |
| 10 | G 1 | – | G 3 | - | |
| 11 | G 1 | W 2 | R 3 | - | |



OBSERVER No. 2.

Distance, 2,000 yards.

| Observation. | Lights shown. | | | | Report. |
|---|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | - | correct. |
| 2 | G 1 | – | W 3 | - | |
| 3 | G 1 | – | G 3 | - | r g |
| 4 | R 1 | G 2 | G 3 | - | r g g |
| 5 | W 1 | R 2 | G 3 | - | w g g* |
| 6 | G 1 | W 2 | R 3 | - | correct. |
| 7 | G 1 | – | R 3 | - | |
| 8 | R 1 | W 2 | G 3 | - | g w r |
| 9 | W 1 | – | R 3 | - | g r |
| 10 | R 1 | | R 3 | - | correct. |
| 11 | G 1 | R 2 | W 3 | - | w r w |

* First said g g g.

Distance, 1,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | - | correct. |
| 2 | G 1 | R 2 | W 3 | - | |
| 3 | R 1 | W 2 | G 3 | - | |
| 4 | R 1 | G 2 | G 3 | - | r g w |
| 5 | W 1 | R 2 | G 3 | - | correct. |
| 6 | G 1 | – | R 3 | - | |
| 7 | G 1 | – | W 3 | - | |
| 8 | R 1 | – | R 3 | - | |
| 9 | W 1 | – | R 3 | - | |
| 10 | G 1 | – | G 3 | - | g r* |
| 11 | G 1 | W 2 | R 3 | - | correct. |

* Uncertain.

OBSERVER No. 3.

Distance, 2,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | - | correct. |
| 2 | G 1 | – | W 3 | - | g r |
| 3 | G 1 | – | G 3 | - | correct. |
| 4 | R 1 | G 2 | G 3 | - | |
| 5 | W 1 | R 2 | G 3 | - | |
| 6 | G 1 | W 2 | R 3 | - | |
| 7 | G 1 | – | R 3 | - | |
| 8 | R 1 | W 2 | G 3 | - | correct. |
| 9 | W 1 | – | R 3 | - | |
| 10 | R 1 | – | R 3 | - | |
| 11 | G 1 | R 2 | W 3 | - | |

Distance, 2,000 yards (with binoculars).

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | - | correct. |
| 2 | W 1 | R 2 | G 3 | - | |
| 3 | W 1 | – | R 3 | - | |
| 4 | R 1 | – | R 3 | - | |
| 5 | R 1 | W 2 | G 3 | - | |
| 6 | R 1 | G 2 | G 3 | - | correct. |
| 7 | G 1 | R 2 | W 3 | - | |
| 8 | G 1 | – | R 3 | - | |
| 9 | G 1 | – | G 3 | - | |
| 10 | G 1 | – | W 3 | - | |
| 11 | G 1 | W 2 | R 3 | - | |

Distance, 1,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | - | correct. |
| 2 | G 1 | R 2 | W 3 | - | |
| 3 | R 1 | W 2 | G 3 | - | |
| 4 | R 1 | G 2 | G 3 | - | |
| 5 | W 1 | R 2 | G 3 | - | |
| 6 | G 1 | – | R 3 | - | correct. |
| 7 | G 1 | – | W 3 | - | |
| 8 | R 1 | – | R 3 | - | |
| 9 | W 1 | – | R 3 | - | |
| 10 | G 1 | – | G 3 | - | |
| 11 | G 1 | W 2 | R 3 | - | |

OBSERVER No. 4.

Distance, 2,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | - | correct. |
| 2 | G 1 | G 2 | W 3 | - | |
| 3 | R 1 | – | R 3 | - | |
| 4 | W 1 | – | G 3 | - | |
| 5 | W 1 | G 2 | G 3 | - | |
| 6 | G 1 | R 2 | W 3 | - | correct. |
| 7 | R 1 | W 2 | G 3 | - | |
| 8 | G 1 | – | W 3 | - | |
| 9 | W 1 | W 2 | G 3 | - | |
| 10 | R 1 | – | W 3 | - | |
| 11 | G 1 | – | R 3 | - | |

Distance, 1,000 yards.

| Observation. | Lights shown. | | | | Report. |
|---|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | - | correct. |
| 2 | G 1 | – | G 3 | - | |
| 3 | G 1 | – | R 3 | - | |
| 4 | G 1 | R 2 | W 3 | - | |
| 5 | G 1 | – | W 3 | - | |
| 6 | G 1 | W 2 | R 3 | - | correct. |
| 7 | R 1 | – | R 3 | - | |
| 8 | R 1 | G 2 | G 3 | - | |
| 9 | R 1 | W 2 | G 3 | - | |
| 10 | W 1 | – | R 3 | - | |
| 11 | W 1 | R 2 | G 3 | - | |

OBSERVER No. 5.

Distance, 2,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | - | |
| 2 | G 1 | G 2 | W 3 | - | |
| 3 | R 1 | – | R 3 | - | |
| 4 | W 1 | – | G 3 | - | correct. |
| 5 | W 1 | G 2 | G 3 | - | |
| 6 | G 1 | R 2 | W 3 | - | |
| 7 | R 1 | W 2 | G 3 | - | |
| 8 | W 1 | – | W 3 | - | g r |
| 9 | W 1 | W 2 | G 3 | - | |
| 10 | R 1 | – | W 3 | - | correct. |
| 11 | G 1 | – | R 3 | - | |

Distance, 1,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | - | correct. |
| 2 | G 1 | – | G 3 | - | w g |
| 3 | G 1 | – | R 3 | - | |
| 4 | G 1 | R 2 | W 3 | - | |
| 5 | G 1 | – | W 3 | - | |
| 6 | G 1 | W 2 | R 3 | - | |
| 7 | R 1 | – | R 3 | - | correct. |
| 8 | R 1 | G 2 | G 3 | - | |
| 9 | R 1 | W 2 | G 3 | - | |
| 10 | W 1 | – | R 3 | - | |
| 11 | W 1 | R 2 | G 3 | - | |

OBSERVER No 6.

Distance, 2,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | - | correct |
| 2 | G 1 | G 2 | W 3 | - | g r w |
| 3 | R 1 | – | R 3 | - | |
| 4 | W 1 | – | G 3 | - | |
| 5 | W 1 | G 2 | G 3 | - | correct. |
| 6 | G 1 | R 2 | W 3 | - | |
| 7 | R 1 | W 2 | G 3 | - | |
| 8 | G 1 | – | W 3 | - | |
| 9 | W 1 | W 2 | G 3 | - | g g g |
| 10 | R 1 | – | W 3 | - | correct. |
| 11 | G 1 | – | R 3 | - | |

Distance, 1,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | - | |
| 2 | G 1 | – | G 3 | - | |
| 3 | G 1 | – | R 3 | - | |
| 4 | G 1 | R 2 | W 3 | - | |
| 5 | G 1 | – | W 3 | - | |
| 6 | G 1 | W 2 | R 3 | - | correct. |
| 7 | R 1 | – | R 3 | - | |
| 8 | R 1 | G 2 | G 3 | - | |
| 9 | R 1 | W 2 | G 3 | - | |
| 10 | W 1 | – | R 3 | - | |
| 11 | W 1 | R 2 | G 3 | - | |

OBSERVER No. 7.

Distance, 1,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | - | |
| 2 | G 1 | – | R 3 | - | |
| 3 | W 1 | R 2 | G 3 | - | |
| 4 | R 1 | – | R 3 | - | |
| 5 | G 1 | R 2 | W 3 | - | |
| 6 | G 1 | – | W 3 | - | correct. |
| 7 | G 1 | W 2 | R 3 | - | |
| 8 | W 1 | – | R 3 | - | |
| 9 | R 1 | G 2 | G 3 | - | |
| 10 | G 1 | – | G 3 | - | |
| 11 | R 1 | W 2 | G 3 | - | |

OBSERVER No. 8.

Distance, 2,000 yards.

| Observation. | Lights shown. | | | Report. |
|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | } correct. |
| 2 | W 1 | R 2 | G 3 | |
| 3 | W 1 | – | R 3 | |
| 4 | R 1 | – | R 3 | |
| 5 | R 1 | W 2 | G 3 | |
| 6 | R 1 | G 2 | G 3 | |
| 7 | G 1 | R 2 | W 3 | |
| 8 | G 1 | – | R 3 | |
| 9 | G 1 | – | G 3 | |
| 10 | G 1 | – | W 3 | |
| 11 | G 1 | W 2 | R 3 | |

Distance, 1,000 yards.

| | | | | |
|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | } correct. |
| 2 | G 1 | – | R 3 | |
| 3 | W 1 | R 2 | G 3 | |
| 4 | R 1 | – | R 3 | |
| 5 | G 1 | R 2 | W 3 | |
| 6 | G 1 | – | W 3 | |
| 7 | G 1 | W 2 | R 3 | |
| 8 | W 1 | – | R 3 | |
| 9 | R 1 | G 2 | G 3 | |
| 10 | G 1 | – | G 3 | |
| 11 | R 1 | W 2 | G 3 | |

OBSERVER No. 9.

Distance, 2,000 yards.

| | | | | |
|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | correct. |
| 2 | W 1 | R 2 | G 3 | r r |
| 3 | W 1 | – | R 3 | } correct. |
| 4 | R 1 | – | R 3 | |
| 5 | R 1 | W 2 | G 3 | r w |
| 6 | R 1 | G 2 | G 3 | r |
| 7 | G 1 | R 2 | W 3 | r w |
| 8 | G 1 | – | R 3 | r |
| 9 | G 1 | – | G 3 | – |
| 10 | G 1 | – | W 3 | w |
| 11 | G 1 | W 2 | R 3 | w r |

Distance, 1,000 yards.

| | | | | |
|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | } correct. |
| 2 | G 1 | – | R 3 | |
| 3 | W 1 | R 2 | G 3 | |
| 4 | R 1 | – | R 3 | |
| 5 | G 1 | R 2 | G 3 | |
| 6 | R 1 | – | W 3 | |
| 7 | G 1 | W 2 | R 3 | |
| 8 | W 1 | – | R 3 | |
| 9 | R 1 | G 2 | G 3 | |
| 10 | G 1 | – | G 3 | |
| 11 | R 1 | W 2 | R 3 | |

## ELEVENTH NIGHT—FEBRUARY 11TH.

There was a slight haze throughout, and the moon being nearly full the lights could not be distinguished at 3,000 yards. A shower of rain fell while the observations at 2,000 yards were being taken. It was fine at 1,000 yards.

OBSERVER No. 1.

Distance, 2,000 yards.

| | | | | |
|---|---|---|---|---|
| 1 | W 1 | W 2 | R 3 | w w w |
| 2 | R 1 | – | G 3 | correct. |
| 3 | G 1 | G 2 | R 3 | r g w |
| 4 | G 1 | – | W 3 | } correct. |
| 5 | G 1 | R 2 | G 3 | |
| 6 | R 1 | – | W 3 | |
| 7 | W 1 | R 2 | W 3 | r r r |
| 8 | G 1 | – | G 3 | correct. |
| 9 | W 1 | G 2 | W 3 | r g r |
| 10 | R 1 | R 2 | R 3 | correct. |

Distance 1,000 yards.

| Observation. | Lights shown. | | | Report. |
|---|---|---|---|---|
| 1 | W 1 | – | G 3 | } correct. |
| 2 | G 1 | W 2 | W 3 | |
| 3 | R 1 | G 2 | R 3 | |
| 4 | W 1 | – | R 3 | |
| 5 | G 1 | W 2 | G 3 | |
| 6 | R 1 | R 2 | G 3 | |
| 7 | G 1 | – | W 3 | |
| 8 | R 1 | – | R 3 | |
| 9 | W 1 | G 2 | R 3 | r g r |
| 10 | R 1 | R 2 | R 3 | correct. |

OBSERVER No. 2.

Distance 2,000 yards.

| | | | | |
|---|---|---|---|---|
| 1 | W 1 | W 2 | R 3 | r w w |
| 2 | R 1 | – | G 3 | correct. |
| 3 | G 1 | G 2 | R 3 | r g w |
| 4 | G 1 | – | W 3 | correct. |
| 5 | G 1 | R 2 | G 3 | r w r |
| 6 | R 1 | – | W 3 | g r |
| 7 | W 1 | R 2 | W 3 | r r w |
| 8 | G 1 | – | G 3 | r r |
| 9 | W 1 | G 2 | W 3 | w r w |
| 10 | R 1 | R 2 | R 3 | r w w |

Distance 1,000 yards.

| | | | | |
|---|---|---|---|---|
| 1 | W 1 | – | G 3 | correct. |
| 2 | G 1 | W 2 | W 3 | g r w |
| 3 | R 1 | G 2 | R 3 | correct. |
| 4 | W 1 | – | R 3 | g r |
| 5 | G 1 | W 2 | G 3 | g r g |
| 6 | R 1 | R 2 | G 3 | } correct. |
| 7 | G 1 | – | W 3 | |
| 8 | R 1 | – | R 3 | |
| 9 | W 1 | G 2 | R 3 | |
| 10 | R 1 | R 2 | R 3 | |

OBSERVER No. 3.

Distance 2,000 yards.

| | | | | |
|---|---|---|---|---|
| 1 | W 1 | W 2 | R 3 | g w r |
| 2 | R 1 | – | G 3 | } correct. |
| 3 | G 1 | G 2 | R 3 | |
| 4 | G 1 | – | W 3 | |
| 5 | G 1 | R 2 | G 3 | |
| 6 | R 1 | – | W 3 | |
| 7 | W 1 | R 2 | W 3 | |
| 8 | G 1 | – | G 3 | |
| 9 | W 1 | G 2 | W 3 | r g w |
| 10 | R 1 | R 2 | R 3 | correct. |

Distance 1,000 yards.

| | | | | |
|---|---|---|---|---|
| 1 | W 1 | – | G 3 | r g |
| 2 | G 1 | W 2 | W 3 | } correct. |
| 3 | R 1 | G 2 | R 3 | |
| 4 | W 1 | – | R 3 | |
| 5 | G 1 | W 2 | R 3 | |
| 6 | R 1 | R 2 | G 3 | |
| 7 | G 1 | – | W 3 | |
| 8 | R 1 | – | R 3 | |
| 9 | W 1 | G 2 | R 3 | r g r |
| 10 | R 1 | R 2 | R 3 | correct. |

OBSERVER No. 4.

Distance 2,000 yards.

| | | | | |
|---|---|---|---|---|
| 1 | G 1 | G 2 | R 3 | } correct. |
| 2 | R 1 | – | R 3 | |
| 3 | G 1 | – | W 3 | |
| 4 | G 1 | R 2 | G 3 | |
| 5 | W 1 | G 2 | W 3 | |
| 6 | R 1 | – | W 3 | |
| 7 | G 1 | W 2 | W 3 | |
| 8 | R 1 | G 2 | W 3 | |
| 9 | W 1 | – | G 3 | |
| 10 | R 1 | R 2 | R 3 | |



Distance 1,000 yards.

| Observation. | Lights shown. | | | Report. |
|---|---|---|---|---|
| 1 | W 1 | R 2 | W 3 | } correct. |
| 2 | G 1 | W 2 | G 3 | |
| 3 | W 1 | – | W 3 | |
| 4 | R 1 | – | G 3 | |
| 5 | G 1 | – | R 3 | |
| 6 | R 1 | G 2 | G 3 | |
| 7 | W 1 | R 2 | G 3 | |
| 8 | G 1 | – | W 3 | |
| 9 | G 1 | G 2 | G 3 | |
| 10 | R 1 | R 2 | R 3 | |

OBSERVER No. 5.

Distance 2,000 yards.

| | | | | |
|---|---|---|---|---|
| 1 | G 1 | G 2 | R 3 | g g w |
| 2 | R 1 | – | R 3 | r w |
| 3 | G 1 | – | W 3 | r g |
| 4 | G 1 | R 2 | G 3 | r r g |
| 5 | W 1 | G 2 | W 3 | r g w |
| 6 | R 1 | – | W 3 | correct. |
| 7 | G 1 | W 2 | W 3 | r w g |
| 8 | R 1 | G 2 | W 3 | correct. |
| 9 | W 1 | – | G 3 | g g* |
| 10 | R 1 | R 2 | R 3 | r r |

* First said r g.

Distance 1,000 yards.

| | | | | |
|---|---|---|---|---|
| 1 | W 1 | R 2 | W 3 | } correct. |
| 2 | G 1 | W 2 | G 3 | |
| 3 | W 1 | – | W 3 | |
| 4 | R 1 | – | G 3 | |
| 5 | G 1 | – | R 3 | |
| 6 | R 1 | G 2 | G 3 | |
| 7 | W 1 | R 2 | G 3 | |
| 8 | G 1 | – | W 3 | |
| 9 | G 1 | G 2 | G 3 | g g w |
| 10 | R 1 | R 2 | R 3 | correct. |

OBSERVER No. 6.

Distance 2,000 yards.

| | | | | |
|---|---|---|---|---|
| 1 | G 1 | G 2 | R 3 | } correct. |
| 2 | R 1 | – | R 3 | |
| 3 | G 1 | – | W 3 | |
| 4 | G 1 | R 2 | G 3 | |
| 5 | W 1 | G 2 | W 3 | g g w |
| 6 | R 1 | – | W 3 | w |
| 7 | G 1 | W 2 | W 3 | g w |
| 8 | R 1 | G 2 | W 3 | r w |
| 9 | W 1 | – | G 3 | g g |
| 10 | R 1 | R 2 | R 3 | r w g |

Distance 1,000 yards.

| Observation. | Lights shown. | | | Report. |
|---|---|---|---|---|
| 1 | W 1 | R 2 | W 3 | g r w |
| 2 | G 1 | W 2 | G 3 | correct. |
| 3 | W 1 | – | W 3 | r w |
| 4 | R 1 | – | G 3 | } correct. |
| 5 | G 1 | – | R 3 | |
| 6 | R 1 | G 2 | G 3 | |
| 7 | W 1 | R 2 | G 3 | |
| 8 | G 1 | – | W 3 | |
| 9 | G 1 | G 2 | G 3 | |
| 10 | R 1 | R 2 | R 3 | |

OBSERVER No. 7.

Distance 1,000 yards.

| | | | | |
|---|---|---|---|---|
| 1 | G 1 | W 2 | G 3 | } correct. |
| 2 | W 1 | – | R 3 | |
| 3 | R 1 | G 2 | G 3 | r g w |
| 4 | G 1 | – | W 3 | correct. |
| 5 | W 1 | W 2 | W 3 | g w w |
| 6 | R 1 | W 2 | G 3 | } correct. |
| 7 | G 1 | – | G 3 | |
| 8 | G 1 | R 2 | W 3 | |
| 9 | W 1 | – | G 3 | |
| 10 | R 1 | R 2 | R 3 | |

OBSERVER No. 8.

Distance 1,000 yards.

| | | | | |
|---|---|---|---|---|
| 1 | G 1 | W 2 | G 3 | } correct. |
| 2 | W 1 | – | R 3 | |
| 3 | R 1 | G 2 | G 3 | |
| 4 | G 1 | – | W 3 | |
| 5 | W 1 | W 2 | W 3 | } correct. |
| 6 | R 1 | W 2 | G 3 | |
| 7 | G 1 | – | G 3 | |
| 8 | G 1 | R 2 | W 3 | |
| 9 | W 1 | – | G 3 | |
| 10 | R 1 | R 2 | R 3 | |

OBSERVER No. 9.

Distance 1,000 yards.

| | | | | |
|---|---|---|---|---|
| 1 | G 1 | W 2 | G 3 | } correct. |
| 2 | W 1 | – | R 3 | |
| 3 | R 1 | G 2 | G 3 | |
| 4 | G 1 | – | W 3 | |
| 5 | W 1 | W 2 | W 3 | } correct. |
| 6 | R 1 | W 2 | G 3 | |
| 7 | G 1 | – | G 3 | |
| 8 | G 1 | R 2 | W 3 | |
| 9 | W 1 | – | G 3 | |
| 10 | R 1 | R 2 | R 3 | |

## SECOND SERIES, NOVEMBER 13th to 25th, 1911.

### FIRST NIGHT—NOVEMBER 13TH.

The weather throughout was fine and very clear.

OBSERVER No. 10.

Distance 3,000 yards.

| Observation. | Lights shown. | | | Report. |
|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | g r g |
| 2 | G 1 | G 2 | W 3 | g g r |
| 3 | R 1 | – | R 3 | } correct. |
| 4 | W 1 | – | G 3 | |
| 5 | W 1 | G 2 | G 3 | |
| 6 | G 1 | R 2 | W 3 | g r r |
| 7 | R 1 | W 2 | G 3 | } correct. |
| 8 | G 1 | – | W 3 | |
| 9 | W 1 | W 2 | G 3 | |
| 10 | R 1 | – | W 3 | w r |
| 11 | G 1 | – | R 3 | correct. |

Distance 3,000 yards (with binoculars).

| Observation. | Lights shown. | | | Report. |
|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | correct. |
| 2 | G 1 | – | G 3 | w w |
| 3 | G 1 | – | R 3 | correct. |
| 4 | G 1 | R 2 | W 3 | g r r |
| 5 | G 1 | – | W 3 | w r |
| 6 | G 1 | W 2 | R 3 | g r r |
| 7 | R 1 | – | R 3 | } correct. |
| 8 | R 1 | G 2 | G 3 | |
| 9 | R 1 | W 2 | G 3 | |
| 10 | W 1 | – | R 3 | r r |
| 11 | W 1 | R 2 | G 3 | r r g |

Distance 2,000 yards.

| Observation. | Lights shown. | | | | | Report. |
|---|---|---|---|---|---|---|
| 1 | - W 1 | W 2 | W 3 | - | - | correct. |
| 2 | - R 1 | W 2 | G 3 | - | - | |
| 3 | - W 1 | R 2 | G 3 | - | - | g w r |
| 4 | - G 1 | – | W 3 | - | - | g r |
| 5 | - W 1 | – | R 3 | - | - | g r |
| 6 | - G 1 | W 2 | R 3 | - | - | correct. |
| 7 | - G 1 | – | G 3 | - | - | |
| 8 | - R 1 | – | R 3 | - | - | |
| 9 | - G 1 | – | R 3 | - | - | |
| 10 | - R 1 | G 2 | G 3 | - | - | |
| 11 | - G 1 | R 2 | W 3 | - | - | g w r |

Distance 2,000 yards (with binoculars).

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | - W 1 | W 2 | W 3 | - | - | correct. |
| 2 | - W 1 | R 2 | G 3 | - | - | r r g |
| 3 | - W 1 | – | R 3 | - | - | correct. |
| 4 | - R 1 | – | R 3 | - | - | |
| 5 | - R 1 | W 2 | G 3 | - | - | |
| 6 | - R 1 | G 2 | G 3 | - | - | |
| 7 | - G 1 | R 2 | W 3 | - | - | g r r |
| 8 | - G 1 | – | R 3 | - | - | correct. |
| 9 | - G 1 | – | G 3 | - | - | |
| 10 | - G 1 | – | W 3 | - | - | g r |
| 11 | - G 1 | W 2 | R 3 | - | - | g g r |

Distance 2,000 yards, (with binoculars).

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | - W 1 | W 2 | W 3 | - | - | correct. |
| 2 | - G 1 | R 2 | W 3 | - | - | g r r |
| 3 | - R 1 | W 2 | G 3 | - | - | correct. |
| 4 | - R 1 | G 2 | G 3 | - | - | |
| 5 | - W 1 | R 2 | G 3 | - | - | r r g |
| 6 | - G 1 | – | R 3 | - | - | correct. |
| 7 | - G 1 | – | W 3 | - | - | |
| 8 | - R 1 | – | R 3 | - | - | |
| 9 | - W 1 | – | R 3 | - | - | |
| 10 | - G 1 | – | G 3 | - | - | w g |
| 11 | - G 1 | W 2 | R 3 | - | - | correct. |

Distance 1,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | - W 1 | W 2 | W 3 | - | - | g g g |
| 2 | - W 1 | – | R 3 | - | - | g r |
| 3 | - G 1 | – | R 3 | - | - | correct. |
| 4 | - R 1 | – | R 3 | - | - | |
| 5 | - G 1 | W 2 | R 3 | - | - | |
| 6 | - W 1 | R 2 | G 3 | - | - | |
| 7 | - R 1 | W 2 | G 3 | - | - | |
| 8 | - G 1 | – | G 3 | - | - | g r |
| 9 | - R 1 | G 2 | G 3 | - | - | correct. |
| 10 | - G 1 | R 2 | W 3 | - | - | g r r |
| 11 | - G 1 | – | W 3 | - | - | g r |

Distance 1,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | - W 1 | W 2 | W 3 | - | - | w w r |
| 2 | - G 1 | – | W 3 | - | - | g r |
| 3 | - G 1 | – | G 3 | - | - | g r |
| 4 | - R 1 | G 2 | G 3 | - | - | correct. |
| 5 | - W 1 | R 2 | G 3 | - | - | |
| 6 | - G 1 | W 2 | R 3 | - | - | |
| 7 | - G 1 | – | R 3 | - | - | |
| 8 | - R 1 | W 2 | G 3 | - | - | |
| 9 | - W 1 | – | R 3 | - | - | |
| 10 | - R 1 | – | R 3 | - | - | r w |
| 11 | - G 1 | R 2 | W 3 | - | - | g r r |

Distance 500 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | - W 1 | W 2 | W 3 | - | - | correct. |
| 2 | - R 1 | – | R 3 | - | - | |
| 3 | - R 1 | W 2 | G 3 | - | - | |
| 4 | - R 1 | G 2 | G 3 | - | - | r g w |
| 5 | - G 1 | – | R 3 | - | - | correct. |
| 6 | - G 1 | W 2 | R 3 | - | - | |
| 7 | - G 1 | – | W 3 | - | - | g r |
| 8 | - G 1 | R 2 | W 3 | - | - | g r r |
| 9 | - G 1 | – | G 3 | - | - | w g |
| 10 | - W 1 | R 2 | G 3 | - | - | correct. |
| 11 | - W 1 | – | R 3 | - | - | |

Observer No 11.

Distance 3,000 yards.

| Observation. | Lights shown. | | | | | Report. |
|---|---|---|---|---|---|---|
| 1 | - W 1 | W 2 | W 3 | - | - | correct. |
| 2 | - G 1 | G 2 | W 3 | - | - | |
| 3 | - R 1 | – | R 3 | - | - | |
| 4 | - W 1 | – | G 3 | - | - | |
| 5 | - W 1 | G 2 | G 3 | - | - | |
| 6 | - G 1 | R 2 | W 3 | - | - | |
| 7 | - R 1 | W 2 | G 3 | - | - | |
| 8 | - G 1 | – | W 3 | - | - | |
| 9 | - W 1 | W 2 | G 3 | - | - | |
| 10 | - R 1 | – | W 3 | - | - | |
| 11 | - G 1 | – | R 3 | - | - | |

Distance 3,000 yards (with binoculars).

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | - W 1 | W 2 | W 3 | - | - | correct. |
| 2 | - G 1 | – | G 3 | - | - | |
| 3 | - G 1 | – | R 3 | - | - | |
| 4 | - G 1 | R 2 | W 3 | - | - | |
| 5 | - G 1 | – | W 3 | - | - | |
| 6 | - G 1 | W 2 | R 3 | - | - | |
| 7 | - R 1 | – | R 3 | - | - | |
| 8 | - R 1 | G 2 | G 3 | - | - | |
| 9 | - R 1 | W 2 | G 3 | - | - | |
| 10 | - W 1 | – | R 3 | - | - | |
| 11 | - W 1 | R 2 | G 3 | - | - | |

Distance 2,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | - W 1 | W 2 | W 3 | - | - | correct. |
| 2 | - R 1 | W 2 | G 3 | - | - | |
| 3 | - W 1 | R 2 | G 3 | - | - | |
| 4 | - G 1 | – | W 3 | - | - | |
| 5 | - W 1 | – | R 3 | - | - | |
| 6 | - G 1 | W 2 | R 3 | - | - | |
| 7 | - G 1 | – | G 3 | - | - | |
| 8 | - R 1 | – | R 3 | - | - | |
| 9 | - G 1 | – | R 3 | - | - | |
| 10 | - R 1 | G 2 | G 3 | - | - | |
| 11 | - G 1 | R 2 | W 3 | - | - | |

Distance 2,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | - W 1 | W 2 | W 3 | - | - | correct. |
| 2 | - G 1 | R 2 | W 3 | - | - | |
| 3 | - R 1 | W 2 | G 3 | - | - | |
| 4 | - R 1 | G 2 | G 3 | - | - | |
| 5 | - W 1 | R 2 | G 3 | - | - | |
| 6 | - G 1 | – | R 3 | - | - | |
| 7 | - G 1 | – | W 3 | - | - | |
| 8 | - R 1 | – | R 3 | - | - | |
| 9 | - G 1 | – | R 3 | - | - | |
| 10 | - R 1 | G 2 | G 3 | - | - | |
| 11 | - G 1 | W 2 | R 3 | - | - | |

Distance 1,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | - W 1 | W 2 | W 3 | - | - | correct. |
| 2 | - W 1 | – | R 3 | - | - | |
| 3 | - G 1 | – | R 3 | - | - | |
| 4 | - R 1 | – | R 3 | - | - | correct.* |
| 5 | - G 1 | W 2 | R 3 | - | - | |
| 6 | - W 1 | R 2 | G 3 | - | - | |
| 7 | - R 1 | W 2 | G 3 | - | - | |
| 8 | - G 1 | – | G 3 | - | - | correct. |
| 9 | - R 1 | G 2 | G 3 | - | - | |
| 10 | - G 1 | R 2 | W 3 | - | - | |
| 11 | - G 1 | – | W 3 | - | - | |

* First said r w.

Distance 500 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | - W 1 | W 2 | W 3 | - | - | correct. |
| 2 | - R 1 | – | R 3 | - | - | |
| 3 | - R 1 | W 2 | G 3 | - | - | |
| 4 | - R 1 | G 2 | G 3 | - | - | |
| 5 | - G 1 | – | R 3 | - | - | |
| 6 | - G 1 | W 2 | R 3 | - | - | |
| 7 | - G 1 | – | W 3 | - | - | |
| 8 | - G 1 | R 2 | W 3 | - | - | |
| 9 | - G 1 | – | G 3 | - | - | |
| 10 | - W 1 | R 2 | G 3 | - | - | |
| 11 | - W 1 | – | R 3 | - | - | |



Observer No. 12.

Distance 3,000 yards.

| Observation. | Lights shown. | | | | | Report. |
|---|---|---|---|---|---|---|
| 1 | - W 1 | W 2 | W 3 | - | - | correct. |
| 2 | - G 1 | G 2 | W 3 | - | - | |
| 3 | - R 1 | – | R 3 | - | - | |
| 4 | - W 1 | – | G 3 | - | - | |
| 5 | - W 1 | G 2 | G 3 | - | - | |
| 6 | - G 1 | R 2 | W 3 | - | - | |
| 7 | - R 1 | W 2 | G 3 | - | - | |
| 8 | - G 1 | – | W 3 | - | - | |
| 9 | - W 1 | W 2 | G 3 | - | - | |
| 10 | - R 1 | – | W 3 | - | - | |
| 11 | - G 1 | – | R 3 | - | - | |

Distance 3,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | - W 1 | W 2 | W 3 | - | - | correct. |
| 2 | - G 1 | – | G 3 | - | - | |
| 3 | - G 1 | – | R 3 | - | - | |
| 4 | - G 1 | R 2 | W 3 | - | - | |
| 5 | - G 1 | – | W 3 | - | - | |
| 6 | - G 1 | W 2 | R 3 | - | - | |
| 7 | - R 1 | – | R 3 | - | - | |
| 8 | - R 1 | G 2 | G 3 | - | - | |
| 9 | - R 1 | W 2 | G 3 | - | - | |
| 10 | - W 1 | – | R 3 | - | - | |
| 11 | - W 1 | R 2 | G 3 | - | - | |

Distance 3,000 yards (with binoculars).

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | - W 1 | W 2 | W 3 | - | - | correct. |
| 2 | - W 1 | G 2 | R 3 | - | - | |
| 3 | - G 1 | G 2 | G 3 | - | - | |
| 4 | - R 1 | – | W 3 | - | - | |
| 5 | - G 1 | G 2 | W 3 | - | - | |
| 6 | - G 1 | – | G 3 | - | - | |
| 7 | - R 1 | – | W 3 | - | - | |
| 8 | - R 1 | G 2 | W 3 | - | - | |
| 9 | - G 1 | – | W 3 | - | - | |
| 10 | - W 1 | – | G 3 | - | - | |
| 11 | - R 1 | W 2 | G 3 | - | - | |

Distance 2,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | - W 1 | W 2 | W 3 | - | - | correct. |
| 2 | - R 1 | W 2 | G 3 | - | - | |
| 3 | - W 1 | R 2 | G 3 | - | - | |
| 4 | - G 1 | – | W 3 | - | - | |
| 5 | - W 1 | – | R 3 | - | - | |
| 6 | - G 1 | W 2 | R 3 | - | - | |
| 7 | - G 1 | – | G 3 | - | - | |
| 8 | - R 1 | – | R 3 | - | - | |
| 9 | - G 1 | – | R 3 | - | - | |
| 10 | - R 1 | G 2 | G 3 | - | - | |
| 11 | - G 1 | R 2 | W 3 | - | - | |

Distance 2,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | - W 1 | W 2 | W 3 | - | - | correct. |
| 2 | - G 1 | R 2 | W 3 | - | - | |
| 3 | - R 1 | W 2 | G 3 | - | - | |
| 4 | - R 1 | G 2 | G 3 | - | - | |
| 5 | - W 1 | R 2 | G 3 | - | - | |
| 6 | - G 1 | – | R 3 | - | - | |
| 7 | - G 1 | – | W 3 | - | - | |
| 8 | - R 1 | – | R 3 | - | - | |
| 9 | - W 1 | – | R 3 | - | - | |
| 10 | - G 1 | – | G 3 | - | - | |
| 11 | - G 1 | W 2 | R 3 | - | - | |

Distance 1,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | - W 1 | W 2 | W 3 | - | - | correct. |
| 2 | - W 1 | – | R 3 | - | - | |
| 3 | - G 1 | – | R 3 | - | - | |
| 4 | - R 1 | – | R 3 | - | - | |
| 5 | - G 1 | W 2 | R 3 | - | - | |
| 6 | - W 1 | R 2 | G 3 | - | - | |
| 7 | - R 1 | W 2 | G 3 | - | - | |
| 8 | - G 1 | – | G 3 | - | - | |
| 9 | - R 1 | G 2 | G 3 | - | - | |
| 10 | - G 1 | R 2 | W 3 | - | - | |
| 11 | - G 1 | – | W 3 | - | - | |

Distance 500 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | - W 1 | W 2 | W 3 | - | - | correct. |
| 2 | - R 1 | – | R 3 | - | - | |
| 3 | - R 1 | W 2 | G 3 | - | - | |
| 4 | - R 1 | G 2 | G 3 | - | - | |
| 5 | - G 1 | – | R 3 | - | - | |
| 6 | - G 1 | W 2 | R 3 | - | - | |
| 7 | - G 1 | – | G 3 | - | - | |
| 8 | - R 1 | – | R 3 | - | - | |
| 9 | - G 1 | – | R 3 | - | - | |
| 10 | - R 1 | G 2 | G 3 | - | - | |
| 11 | - G 1 | R 2 | W 3 | - | - | |

Observer No. 14.

Distance 3,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | - W 1 | W 2 | W 3 | - | - | correct. |
| 2 | - W 1 | G 2 | R 3 | - | - | w r g |
| 3 | - G 1 | G 2 | G 3 | - | - | |
| 4 | - R 1 | – | W 3 | - | - | correct. |
| 5 | - G 1 | G 2 | W 3 | - | - | |
| 6 | - G 1 | – | G 3 | - | - | g g g |
| 7 | - R 1 | – | W 3 | - | - | correct. |
| 8 | - R 1 | G 2 | W 3 | - | - | r w |
| 9 | - G 1 | – | W 3 | - | - | |
| 10 | - W 1 | – | G 3 | - | - | correct. |
| 11 | - R 1 | W 2 | G 3 | - | - | |

Distance 2,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | - W 1 | W 2 | W 3 | - | - | correct. |
| 2 | - W 1 | R 2 | G 3 | - | - | w r |
| 3 | - W 1 | – | R 3 | - | - | |
| 4 | - R 1 | – | R 3 | - | - | |
| 5 | - R 1 | W 2 | G 3 | - | - | |
| 6 | - R 1 | G 2 | G 3 | - | - | |
| 7 | - G 1 | R 2 | W 3 | - | - | correct. |
| 8 | - G 1 | – | R 3 | - | - | |
| 9 | - G 1 | – | G 3 | - | - | |
| 10 | - G 1 | – | W 3 | - | - | |
| 11 | - G 1 | W 2 | R 3 | - | - | |

Distance 1,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | - W 1 | W 2 | W 3 | - | - | |
| 2 | - G 1 | – | W 3 | - | - | |
| 3 | - G 1 | – | G 3 | - | - | |
| 4 | - R 1 | G 2 | G 3 | - | - | |
| 5 | - W 1 | R 2 | G 3 | - | - | |
| 6 | - G 1 | W 2 | R 3 | - | - | correct. |
| 7 | - G 1 | – | R 3 | - | - | |
| 8 | - R 1 | W 2 | G 3 | - | - | |
| 9 | - W 1 | – | R 3 | - | - | |
| 10 | - R 1 | – | R 3 | - | - | |
| 11 | - G 1 | R 2 | W 3 | - | - | |

Observer No. 16.

Distance 3,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | - W 1 | W 2 | W 3 | - | - | correct. |
| 2 | - W 1 | G 2 | R 3 | - | - | w g w |
| 3 | - G 1 | G 2 | G 3 | - | - | g g |
| 4 | - R 1 | – | W 3 | - | - | correct. |
| 5 | - G 1 | G 2 | W 3 | - | - | g w |
| 6 | - G 1 | – | G 3 | - | - | |
| 7 | - R 1 | – | W 3 | - | - | correct. |
| 8 | - R 1 | G 2 | W 3 | - | - | |
| 9 | - G 1 | – | W 3 | - | - | w |
| 10 | - W 1 | – | G 3 | - | - | correct. |
| 11 | - R 1 | W 2 | G 3 | - | - | r w |

Distance 2,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | - W 1 | W 2 | W 3 | - | - | correct. |
| 2 | - W 1 | R 2 | G 3 | - | - | w r |
| 3 | - W 1 | – | R 3 | - | - | correct. |
| 4 | - R 1 | – | R 3 | - | - | |
| 5 | - R 1 | W 2 | G 3 | - | - | r w |
| 6 | - R 1 | G 2 | G 3 | - | - | r g |
| 7 | - G 1 | R 2 | W 3 | - | - | |
| 8 | - G 1 | – | R 3 | - | - | |
| 9 | - G 1 | – | G 3 | - | - | correct. |
| 10 | - G 1 | – | W 3 | - | - | |
| 11 | - G 1 | W 2 | R 3 | - | - | |

Distance 1,000 yards.

| Observation. | Lights shown. | | | | Report. |
|---|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | - - | correct. |
| 2 | G 1 | – | W 3 | - - | |
| 3 | G 1 | – | G 3 | - - | |
| 4 | R 1 | G 2 | G 3 | - - | |
| 5 | W 1 | R 2 | G 3 | - - | |
| 6 | G 1 | W 2 | R 3 | - - | |
| 7 | G 1 | – | R 3 | - - | |
| 8 | R 1 | W 2 | G 3 | - - | |
| 9 | W 1 | – | R 3 | - - | |
| 10 | R 1 | – | R 3 | - - | |
| 11 | G 1 | R 2 | W 3 | - - | |

## SECOND NIGHT—NOVEMBER 14TH.

Weather throughout fine and very clear.

OBSERVER No 10.

Distance 3,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 2 | W 1 | W 3 | - - | correct. |
| 2 | G 2 | G 1 | W 3 | - - | g g r |
| 3 | R 2 | – | R 3 | - - | correct. |
| 4 | W 2 | – | G 3 | - - | |
| 5 | W 2 | G 1 | G 3 | - - | |
| 6 | G 2 | R 1 | W 3 | - - | g w r |
| 7 | R 2 | W 1 | G 3 | - - | correct. |
| 8 | G 2 | – | W 3 | - - | g r |
| 9 | W 2 | W 1 | G 3 | - - | r r g |
| 10 | R 2 | – | W 3 | - - | r r |
| 11 | G 2 | – | R 3 | - - | correct. |

Distance 3,000 yards (with binoculars).

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 2 | W 1 | W 3 | - - | r r r |
| 2 | W 2 | G 1 | R 3 | - - | correct. |
| 3 | G 2 | G 1 | G 3 | - - | w g g |
| 4 | R 2 | – | W 3 | - - | r r |
| 5 | G 2 | G 1 | W 3 | - - | g g r |
| 6 | G 2 | – | G 3 | - - | correct. |
| 7 | R 2 | – | W 3 | - - | |
| 8 | R 2 | G 1 | W 3 | - - | |
| 9 | G 2 | – | W 3 | - - | g r |
| 10 | W 2 | – | G 3 | - - | r g |
| 11 | R 2 | W 1 | G 3 | - - | r r g |

Distance 2,000 yards (with binoculars).

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 2 | W 1 | W 3 | - - | correct. |
| 2 | G 2 | – | G 3 | - - | g w |
| 3 | G 2 | – | R 3 | - - | correct. |
| 4 | G 2 | R 1 | W 3 | - - | |
| 5 | G 2 | – | W 3 | - - | g r |
| 6 | G 2 | W 1 | R 3 | - - | correct. |
| 7 | R 2 | – | R 3 | - - | |
| 8 | R 2 | G 1 | G 3 | - - | |
| 9 | R 2 | W 1 | G 3 | - - | |
| 10 | W 2 | – | R 3 | - - | g r |
| 11 | W 2 | R 1 | G 3 | - - | correct. |

Distance 2,000 yards (with binoculars).

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 2 | W 1 | W 3 | - - | correct. |
| 2 | R 2 | W 1 | G 3 | - - | |
| 3 | W 2 | R 1 | G 3 | - - | |
| 4 | G 2 | – | W 3 | - - | correct. |
| 5 | W 2 | – | R 3 | - - | |
| 6 | G 2 | W 1 | R 3 | - - | |
| 7 | G 2 | – | G 3 | - - | g w |
| 8 | R 2 | – | R 3 | - - | correct. |
| 9 | G 2 | – | R 3 | - - | |
| 10 | R 2 | G 1 | G 3 | - - | |
| 11 | G 2 | R 1 | W 3 | - - | |

Distance 2,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 2 | W 1 | W 3 | - - | correct. |
| 2 | W 2 | – | R 3 | - - | |
| 3 | G 2 | – | R 3 | - - | |
| 4 | R 2 | – | R 3 | - - | |
| 5 | W 2 | G 1 | G 3 | - - | |
| 6 | G 2 | R 1 | W 3 | - - | w w g |
| 7 | R 2 | W 1 | G 3 | - - | w w g |
| 8 | G 2 | – | G 3 | - - | correct. |
| 9 | R 2 | G 1 | G 3 | - - | |
| 10 | G 2 | R 1 | W 3 | - - | g w r |
| 11 | G 2 | – | W 3 | - - | g r |

Distance 1,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 2 | W 1 | W 3 | - - | correct. |
| 2 | G 2 | – | W 3 | - - | |
| 3 | G 2 | – | G 3 | - - | |
| 4 | R 2 | G 1 | G 3 | - - | |
| 5 | W 2 | R 1 | G 3 | - - | |
| 6 | G 2 | W 1 | R 3 | - - | |
| 7 | G 2 | – | R 3 | - - | |
| 8 | R 2 | W 1 | G 3 | - - | |
| 9 | W 2 | – | R 3 | - - | |
| 10 | R 2 | – | R 3 | - - | |
| 11 | G 2 | R 1 | W 3 | - - | |

Distance 500 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 2 | W 1 | W 3 | - - | correct. |
| 2 | W 2 | R 1 | G 3 | - - | |
| 3 | W 2 | – | R 3 | - - | |
| 4 | R 2 | – | R 3 | - - | |
| 5 | R 2 | W 1 | G 3 | - - | |
| 6 | R 2 | G 1 | G 3 | - - | |
| 7 | G 2 | R 1 | W 3 | - - | |
| 8 | G 2 | – | R 3 | - - | |
| 9 | G 2 | – | G 3 | - - | |
| 10 | G 2 | – | W 3 | - - | |
| 11 | G 2 | W 1 | R 3 | - - | |

OBSERVER No. 11.

Distance 3,000 yards (with binoculars).

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 2 | W 1 | W 3 | - - | correct. |
| 2 | G 2 | G 1 | W 3 | - - | |
| 3 | R 2 | – | R 3 | - - | |
| 4 | W 2 | – | G 3 | - - | |
| 5 | W 2 | G 1 | G 3 | - - | |
| 6 | G 2 | R 1 | W 3 | - - | |
| 7 | R 2 | W 1 | G 3 | - - | |
| 8 | G 2 | – | W 3 | - - | g r |
| 9 | W 2 | W 1 | G 3 | - - | correct. |
| 10 | R 2 | – | W 3 | - - | |
| 11 | G 2 | – | R 3 | - - | |

Distance 2,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 2 | W 1 | W 3 | - - | correct. |
| 2 | G 2 | – | G 3 | - - | |
| 3 | G 2 | – | R 3 | - - | |
| 4 | G 2 | R 1 | W 3 | - - | |
| 5 | G 2 | – | W 3 | - - | |
| 6 | G 2 | W 1 | R 3 | - - | |
| 7 | R 2 | – | R 3 | - - | |
| 8 | R 2 | G 1 | G 3 | - - | |
| 9 | R 2 | W 1 | G 3 | - - | |
| 10 | W 2 | – | R 3 | - - | |
| 11 | W 2 | R 1 | G 3 | - - | |

OBSERVER No. 12.

Distance 3,000 yards (with binoculars).

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 2 | W 1 | W 3 | - - | correct. |
| 2 | G 2 | G 1 | W 3 | - - | |
| 3 | R 2 | – | R 3 | - - | |
| 4 | W 2 | – | G 3 | - - | |
| 5 | W 2 | G 1 | G 3 | - - | |
| 6 | G 2 | R 1 | W 3 | - - | |
| 7 | R 2 | W 1 | G 3 | - - | |
| 8 | G 2 | – | W 3 | - - | |
| 9 | W 2 | W 1 | G 3 | - - | |
| 10 | R 2 | – | W 3 | - - | |
| 11 | G 2 | – | R 3 | - - | |

Distance 3,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 2 | W 1 | W 3 | - - | correct. |
| 2 | G 2 | R 1 | W 3 | - - | |
| 3 | R 2 | W 1 | G 3 | - - | |
| 4 | G 2 | R 1 | W 3 | - - | |
| 5 | W 2 | – | G 3 | - - | |
| 6 | G 2 | W 1 | R 3 | - - | |
| 7 | R 2 | – | R 3 | - - | |
| 8 | R 2 | G 1 | G 3 | - - | |
| 9 | R 2 | W 1 | G 3 | - - | |
| 10 | W 2 | – | R 3 | - - | |
| 11 | W 2 | R 1 | G 3 | - - | |



Distance 2,000 yards.

| Observation. | Lights shown. | | | | Report. |
|---|---|---|---|---|---|
| 1 | W 2 | W 1 | W 3 | - - | correct. |
| 2 | G 2 | – | G 3 | - - | |
| 3 | G 2 | – | R 3 | - - | |
| 4 | G 2 | R 1 | W 3 | - - | |
| 5 | G 2 | – | W 3 | - - | |
| 6 | G 2 | W 1 | R 3 | - - | |
| 7 | R 2 | – | R 3 | - - | |
| 8 | R 2 | G 1 | G 3 | - - | |
| 9 | R 2 | W 1 | G 3 | - - | |
| 10 | W 2 | – | R 3 | - - | |
| 11 | W 2 | R 1 | G 3 | - - | |

OBSERVER No. 14.

Distance 3,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 2 | W 1 | W 3 | - - | correct. |
| 2 | G 2 | R 1 | W 3 | - - | r w |
| 3 | R 2 | W 1 | G 3 | - - | correct. |
| 4 | R 2 | G 1 | G 3 | - - | r g |
| 5 | W 2 | R 1 | G 3 | - - | w w g |
| 6 | G 2 | – | R 3 | - - | w r r |
| 7 | G 2 | – | W 3 | - - | correct. |
| 8 | R 2 | – | R 3 | - - | |
| 9 | W 2 | – | R 3 | - - | w |
| 10 | G 2 | – | G 3 | - - | correct. |
| 11 | G 2 | W 1 | R 3 | - - | |

Distance 3,000 yards (with binoculars).

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 2 | W 1 | W 3 | - - | correct. |
| 2 | W 2 | G 1 | R 3 | - - | |
| 3 | G 2 | G 1 | G 3 | - - | |
| 4 | R 2 | – | W 3 | - - | |
| 5 | G 2 | G 1 | W 3 | - - | |
| 6 | G 2 | – | G 3 | - - | correct. |
| 7 | R 2 | – | W 3 | - - | |
| 8 | R 2 | G 1 | W 3 | - - | |
| 9 | G 2 | – | W 3 | - - | |
| 10 | W 2 | – | G 3 | - - | |
| 11 | R 2 | W 1 | G 3 | - - | |

Distance 2,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 2 | W 1 | W 3 | - - | correct. |
| 2 | R 2 | W 1 | G 3 | - - | |
| 3 | W 2 | R 1 | G 3 | - - | |
| 4 | G 2 | – | W 3 | - - | |
| 5 | W 2 | – | R 3 | - - | |
| 6 | G 2 | W 1 | R 3 | - - | correct. |
| 7 | G 2 | – | G 3 | - - | |
| 8 | R 2 | – | R 3 | - - | |
| 9 | G 2 | – | R 3 | - - | |
| 10 | R 2 | G 1 | G 3 | - - | |
| 11 | G 2 | R 1 | W 3 | - - | |

Distance 2,000 yards (with binoculars).

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 2 | W 1 | W 3 | - - | correct. |
| 2 | W 2 | – | R 3 | - - | |
| 3 | G 2 | – | R 3 | - - | |
| 4 | R 2 | – | R 3 | - - | |
| 5 | G 2 | W 1 | R 3 | - - | |
| 6 | W 2 | R 1 | G 3 | - - | correct. |
| 7 | R 2 | W 1 | G 3 | - - | |
| 8 | G 2 | – | G 3 | - - | |
| 9 | R 2 | G 1 | G 3 | - - | |
| 10 | G 2 | R 1 | W 3 | - - | |
| 11 | G 2 | – | W 3 | - - | |

Distance 1,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 2 | W 1 | W 3 | - - | correct. |
| 2 | G 2 | – | W 3 | - - | |
| 3 | G 2 | – | G 3 | - - | |
| 4 | R 2 | G 1 | G 3 | - - | |
| 5 | W 2 | R 1 | G 3 | - - | |
| 6 | G 2 | W 1 | R 3 | - - | |
| 7 | R 2 | – | R 3 | - - | |
| 8 | R 2 | W 1 | G 3 | - - | |
| 9 | W 2 | – | R 3 | - - | |
| 10 | R 2 | – | R 3 | - - | |
| 11 | G 2 | R 1 | W 3 | - - | |

OBSERVER No. 16.

Distance 3,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 2 | W 1 | W 3 | - - | correct. |
| 2 | W 2 | G 1 | R 3 | - - | w r |
| 3 | G 2 | G 1 | G 3 | - - | g g |
| 4 | R 2 | – | W 3 | - - | correct. |
| 5 | G 2 | G 1 | W 3 | - - | g w |
| 6 | G 2 | – | G 3 | - - | — |
| 7 | R 2 | – | W 3 | - - | correct. |
| 8 | R 2 | G 1 | W 3 | - - | r w |
| 9 | G 2 | – | W 3 | - - | correct. |
| 10 | W 2 | – | G 3 | - - | |
| 11 | R 2 | W 1 | G 3 | - - | r w |

Distance 3,000 yards (with binoculars).

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 2 | W 1 | W 3 | - - | correct. |
| 2 | G 2 | R 1 | W 3 | - - | |
| 3 | R 2 | W 1 | G 3 | - - | |
| 4 | R 2 | G 1 | G 3 | - - | |
| 5 | W 2 | R 1 | G 3 | - - | |
| 6 | G 2 | – | R 3 | - - | |
| 7 | G 2 | – | W 3 | - - | |
| 8 | R 2 | – | R 3 | - - | |
| 9 | W 2 | – | R 3 | - - | |
| 10 | G 2 | – | G 3 | - - | |
| 11 | G 2 | W 1 | R 3 | - - | |

Distance 2,000 yards (with binoculars).

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 2 | W 1 | W 3 | - - | correct. |
| 2 | R 2 | W 1 | G 3 | - - | |
| 3 | W 2 | R 1 | G 3 | - - | |
| 4 | G 2 | G 1 | G 3 | - - | |
| 5 | W 2 | – | R 3 | - - | |
| 6 | G 2 | – | G 3 | - - | |
| 7 | R 2 | – | W 3 | - - | |
| 8 | R 2 | G 1 | W 3 | - - | |
| 9 | G 2 | – | W 3 | - - | |
| 10 | W 2 | – | G 3 | - - | |
| 11 | R 2 | W 1 | G 3 | - - | |

Distance 2,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 2 | W 1 | W 3 | - - | correct. |
| 2 | W 2 | – | R 3 | - - | |
| 3 | G 2 | – | R 3 | - - | |
| 4 | R 2 | – | R 3 | - - | |
| 5 | G 2 | W 1 | R 3 | - - | |
| 6 | W 2 | R 1 | G 3 | - - | |
| 7 | R 2 | W 1 | G 3 | - - | |
| 8 | G 2 | – | G 3 | - - | |
| 9 | R 2 | G 1 | G 3 | - - | |
| 10 | G 2 | R 1 | W 3 | - - | |
| 11 | G 2 | – | W 3 | - - | |

Distance 1,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 2 | W 1 | W 3 | - - | correct. |
| 2 | G 2 | – | W 3 | - - | |
| 3 | G 2 | – | G 3 | - - | |
| 4 | R 2 | G 1 | G 3 | - - | |
| 5 | W 2 | R 1 | G 3 | - - | |
| 6 | G 2 | W 1 | R 3 | - - | |
| 7 | G 2 | – | R 3 | - - | |
| 8 | R 2 | W 1 | G 3 | - - | |
| 9 | G 2 | R 1 | W 3 | - - | |
| 10 | G 2 | – | W 3 | - - | |
| 11 | G 2 | – | W 3 | - - | |

## THIRD NIGHT—NOVEMBER 15TH.

Weather throughout fine and clear.

OBSERVER No. 10.

Distance 3,000 yards (with binoculars).

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 2 | W 3 | R 1 | - - | w w w |
| 2 | R 2 | – | G 1 | - - | correct. |
| 3 | G 2 | G 3 | R 1 | - - | |
| 4 | G 2 | – | W 1 | - - | g r |
| 5 | G 2 | R 3 | G 1 | - - | g r w |
| 6 | R 2 | – | W 1 | - - | correct. |
| 7 | W 2 | R 3 | W 1 | - - | r r w |
| 8 | G 2 | – | G 1 | - - | correct. |
| 9 | W 2 | G 3 | W 1 | - - | r g w |
| 10 | R 2 | R 3 | R 1 | - - | r r w |

Distance 3,000 yards (with binoculars).

| Observation. | Lights shown. | | | | Report. |
|---|---|---|---|---|---|
| 1 | R 2 | – | W 1 | - - | correct. |
| 2 | W 2 | – | G 1 | - - | |
| 3 | R 2 | – | R 1 | - - | |
| 4 | G 2 | – | R 1 | - - | |
| 5 | G 2 | W 3 | R 1 | - - | |
| 6 | R 2 | G 3 | R 1 | - - | |
| 7 | W 2 | W 3 | R 1 | - - | |
| 8 | W 2 | G 3 | W 1 | - - | |
| 9 | G 2 | G 3 | W 1 | - - | |
| 10 | R 2 | R 3 | R 1 | - - | |

Distance 3,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | G 2 | G 3 | R 1 | - | - | g g w |
| 2 | R 2 | – | R 1 | - | - | r w |
| 3 | G 2 | – | W 1 | - | - | g r |
| 4 | G 2 | R 3 | G 1 | - | - | g w r |
| 5 | W 2 | G 3 | W 1 | - | - | g w* |
| 6 | R 2 | – | W 1 | - | - | correct. |
| 7 | G 2 | W 3 | W 1 | - | - | g w r |
| 8 | R 2 | G 3 | W 1 | - | - | w w |
| 9 | W 2 | – | G 1 | - | - | r g |
| 10 | R 2 | R 3 | R 1 | - | - | r r w |

* Observers and recorders all agreed at this distance that the middle light looked much dimmer than the other. It has therefore been assumed that this observer failed to see the middle light.

Distance 2,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 2 | R 3 | W 1 | - | - | w w w |
| 2 | G 2 | W 3 | G 1 | - | - | |
| 3 | W 2 | – | W 1 | - | - | correct. |
| 4 | R 2 | – | G 1 | - | - | |
| 5 | G 2 | – | R 1 | - | - | |
| 6 | R 2 | G 3 | G 1 | - | - | r g w |
| 7 | W 2 | R 3 | G 1 | - | - | w w g |
| 8 | G 2 | – | W 1 | - | - | correct. |
| 9 | G 2 | G 3 | G 1 | - | - | g g w |
| 10 | R 2 | R 3 | R 1 | - | - | r w w |

Distance 2,000 yards (with binoculars).

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 2 | – | G 1 | - | - | |
| 2 | G 2 | W 3 | W 1 | - | - | correct. |
| 3 | R 2 | G 3 | R 1 | - | - | |
| 4 | W 2 | – | R 1 | - | - | |
| 5 | G 2 | W 3 | G 1 | - | - | g w w |
| 6 | R 2 | R 3 | G 1 | - | - | |
| 7 | G 2 | – | W 1 | - | - | |
| 8 | R 2 | – | R 1 | - | - | correct. |
| 9 | W 2 | G 3 | R 1 | - | - | |
| 10 | R 2 | R 3 | R 1 | - | - | |

Distance 1,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | G 2 | W 3 | G 1 | - | - | g w w |
| 2 | W 2 | – | R 1 | - | - | correct. |
| 3 | R 2 | G 3 | G 1 | - | - | r g w |
| 4 | G 2 | – | W 1 | - | - | |
| 5 | W 2 | W 3 | W 1 | - | - | |
| 6 | R 2 | W 3 | G 1 | - | - | |
| 7 | G 2 | – | G 1 | - | - | correct. |
| 8 | G 2 | R 3 | W 1 | - | - | |
| 9 | W 2 | – | G 1 | - | - | |
| 10 | R 2 | R 3 | R 1 | - | - | |

Distance 500 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | G 2 | G 3 | R 1 | - | - | |
| 2 | R 2 | – | R 1 | - | - | |
| 3 | G 2 | – | W 1 | - | - | |
| 4 | G 2 | R 3 | G 1 | - | - | |
| 5 | W 2 | G 3 | W 1 | - | - | |
| 6 | R 2 | – | W 1 | - | - | correct. |
| 7 | G 2 | W 3 | W 1 | - | - | |
| 8 | R 2 | G 3 | W 1 | - | - | |
| 9 | W 2 | – | G 1 | - | - | |
| 10 | R 2 | R 3 | R 1 | - | - | |

OBSERVER No. 11.

Distance 3,000 yards.

| Observation. | Lights shown. | | | | Report. |
|---|---|---|---|---|---|
| 1 | W 2 | W 3 | R 1 | - - | |
| 2 | R 2 | – | G 1 | - - | |
| 3 | G 2 | G 3 | R 1 | - - | |
| 4 | G 2 | – | W 1 | - - | correct. |
| 5 | G 2 | R 3 | G 1 | - - | |
| 6 | R 2 | – | W 1 | - - | |
| 7 | W 2 | R 3 | W 1 | - - | |
| 8 | G 2 | – | G 1 | - - | |
| 9 | W 2 | G 3 | W 1 | - | w g r |
| 10 | R 2 | R 3 | R 1 | - | correct. |

Distance 3,000 yards (with binoculars).

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | G 2 | G 3 | R 1 | - | - | |
| 2 | R 2 | – | R 1 | - | - | |
| 3 | G 2 | – | W 1 | - | - | |
| 4 | G 2 | R 3 | G 1 | - | - | |
| 5 | W 2 | G 3 | W 1 | - | - | correct. |
| 6 | R 2 | – | W 1 | - | - | |
| 7 | G 2 | W 3 | W 1 | - | - | |
| 8 | R 2 | G 3 | W 1 | - | - | |
| 9 | W 2 | – | G 1 | - | - | |
| 10 | R 2 | R 3 | R 1 | - | - | |

Distance 2,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 2 | R 3 | W 1 | - | - | correct. |
| 2 | G 2 | W 3 | G 1 | - | - | g r g |
| 3 | W 2 | – | W 1 | - | - | |
| 4 | R 2 | – | G 1 | - | - | |
| 5 | G 2 | – | R 1 | - | - | |
| 6 | R 2 | G 3 | G 1 | - | - | correct. |
| 7 | W 2 | R 3 | G 1 | - | - | |
| 8 | G 2 | – | W 1 | - | - | |
| 9 | G 2 | G 3 | G 1 | - | - | |
| 10 | R 2 | R 3 | R 1 | - | - | |

OBSERVER No. 12.

Distance 3,000 yards (with binoculars).

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 2 | W 3 | R 1 | - | - | |
| 2 | R 2 | – | G 1 | - | - | |
| 3 | G 2 | G 3 | R 1 | - | - | |
| 4 | G 2 | – | W 1 | - | - | |
| 5 | G 2 | R 3 | G 1 | - | - | correct. |
| 6 | R 2 | – | W 1 | - | - | |
| 7 | W 2 | R 3 | W 1 | - | - | |
| 8 | G 2 | – | G 1 | - | - | |
| 9 | W 2 | G 3 | W 1 | - | - | |
| 10 | R 2 | R 3 | R 1 | - | - | |

Distance 3,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | G 2 | G 3 | R 1 | - | - | |
| 2 | R 2 | – | R 1 | - | - | |
| 3 | G 2 | – | W 1 | - | - | |
| 4 | G 2 | R 3 | G 1 | - | - | |
| 5 | W 2 | G 3 | W 1 | - | - | correct. |
| 6 | R 2 | – | W 1 | - | - | |
| 7 | G 2 | W 3 | W 1 | - | - | |
| 8 | R 2 | G 3 | W 1 | - | - | |
| 9 | W 2 | – | G 1 | - | - | |
| 10 | R 2 | R 3 | R 1 | - | - | |

Distance 2,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 2 | R 3 | W 1 | - | - | |
| 2 | G 2 | W 3 | G 1 | - | - | |
| 3 | W 2 | – | W 1 | - | - | |
| 4 | R 2 | – | G 1 | - | - | |
| 5 | G 2 | – | R 1 | - | - | |
| 6 | R 2 | G 3 | G 1 | - | - | correct. |
| 7 | W 2 | R 3 | G 1 | - | - | |
| 8 | G 2 | – | W 1 | - | - | |
| 9 | G 2 | G 3 | G 1 | - | - | |
| 10 | R 2 | R 3 | R 1 | - | - | |



OBSERVER No. 14.

Distance 3,000 yards.

| Observation. | Lights shown. | | | | Report. |
|---|---|---|---|---|---|
| 1 | R 2 | – | W 1 | - - | correct. |
| 2 | W 2 | – | G 1 | - - | w g g |
| 3 | R 3 | – | R 1 | - - | correct. |
| 4 | G 2 | – | W 1 | - - | |
| 5 | G 2 | W 3 | R 1 | - - | w r |
| 6 | R 2 | G 3 | R 1 | - - | r r |
| 7 | W 2 | W 3 | R 1 | - - | correct. |
| 8 | W 2 | G 3 | W 1 | - - | w w |
| 9 | G 2 | G 3 | W 1 | - - | g w |
| 10 | R 2 | R 3 | R 1 | - - | r r |

Distance 2,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 2 | – | G 1 | - | - | |
| 2 | G 2 | W 3 | W 1 | - | - | correct. |
| 3 | R 2 | G 3 | R 1 | - | - | r r |
| 4 | W 2 | – | R 1 | - | - | |
| 5 | G 2 | W 3 | G 1 | - | - | |
| 6 | R 2 | R 3 | G 1 | - | - | correct. |
| 7 | G 2 | – | W 1 | - | - | |
| 8 | R 2 | – | R 1 | - | - | |
| 9 | W 2 | G 3 | R 1 | - | - | w r |
| 10 | R 2 | R 3 | R 1 | - | - | correct. |

Distance 1,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | G 2 | W 3 | G 1 | - | - | |
| 2 | W 2 | – | R 1 | - | - | |
| 3 | R 2 | G 3 | G 1 | - | - | |
| 4 | G 2 | – | W 1 | - | - | |
| 5 | W 2 | W 3 | W 1 | - | - | correct. |
| 6 | R 2 | W 3 | G 1 | - | - | |
| 7 | G 2 | – | G 1 | - | - | |
| 8 | G 2 | R 3 | W 1 | - | - | |
| 9 | W 2 | – | G 1 | - | - | |
| 10 | R 2 | R 3 | R 1 | - | - | |

OBSERVER No. 16.

Distance 3,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | R 2 | – | W 1 | - | - | correct. |
| 2 | W 2 | – | G 1 | - | - | w w |
| 3 | R 2 | – | R 1 | - | - | |
| 4 | G 2 | – | W 1 | - | - | correct. |
| 5 | G 2 | W 3 | R 1 | - | - | w r |
| 6 | R 2 | G 3 | R 1 | - | - | r r |
| 7 | W 2 | W 3 | R 1 | - | - | w r |
| 8 | W 2 | G 3 | W 1 | - | - | w w |
| 9 | G 2 | G 3 | W 1 | - | - | g w |
| 10 | R 2 | R 3 | R 1 | - | - | correct. |

Distance 2,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 2 | – | G 1 | - | - | |
| 2 | G 2 | W 3 | W 1 | - | - | correct. |
| 3 | R 2 | G 3 | R 1 | - | - | r r |
| 4 | W 2 | – | R 1 | - | - | |
| 5 | G 2 | W 3 | G 1 | - | - | |
| 6 | R 2 | R 3 | G 1 | - | - | correct. |
| 7 | G 2 | – | W 1 | - | - | |
| 8 | R 2 | – | R 1 | - | - | |
| 9 | W 2 | G 3 | R 1 | - | - | g g r |
| 10 | R 2 | R 3 | R 1 | - | - | correct. |

Distance 1,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | G 2 | W 3 | G 1 | - | - | |
| 2 | W 2 | – | R 1 | - | - | |
| 3 | R 2 | G 3 | G 1 | - | - | |
| 4 | G 2 | – | W 1 | - | - | |
| 5 | W 2 | W 3 | W 1 | - | - | correct. |
| 6 | R 2 | W 3 | G 1 | - | - | |
| 7 | G 2 | – | G 1 | - | - | |
| 8 | G 2 | R 3 | W 1 | - | - | |
| 9 | W 2 | – | G 1 | - | - | |
| 10 | R 2 | R 3 | R 1 | - | - | |

0 5200

FOURTH NIGHT—NOVEMBER 16.

Weather throughout fine and clear.

OBSERVER No. 10.

Distance 3,000 yards.

| Observation | Lights shown. | | | | Report. |
|---|---|---|---|---|---|
| 1 | W 3 | W 2 | W 1 | - - | correct. |
| 2 | W 3 | R 2 | G 1 | - - | w w g |
| 3 | W 3 | – | R 1 | - - | correct. |
| 4 | R 3 | – | R 1 | - - | |
| 5 | R 3 | W 2 | G 1 | - - | w r g |
| 6 | R 3 | G 2 | G 1 | - - | r |
| 7 | G 3* | R 2 | W 1 | - - | w r |
| 8 | G 3* | – | R 1 | - - | r |
| 9 | G 3* | – | G 1 | - - | — |
| 10 | G 3* | – | W 1 | - - | g r |
| 11 | G 3* | W 2 | R 1 | - - | w r |

* In this series two recorders and three observers failed in most cases to distinguish these greens. The third recorder, who was using binoculars, duly noted them. It has been assumed that in these cases the green was not really visible to the normal unassisted eye, and failure to detect it has not been counted as a mistake.

Distance 3,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 3 | W 2 | W 1 | - | - | r r r |
| 2 | W 3 | G 2 | R 1 | - | - | r g r |
| 3 | G 3 | G 2 | G 1 | - | - | |
| 4 | R 3 | – | W 1 | - | - | |
| 5 | G 3 | G 2 | W 1 | - | - | correct. |
| 6 | G 3 | – | G 1 | - | - | |
| 7 | R 3 | – | W 1 | - | - | r r |
| 8 | R 3 | G 2 | W 1 | - | - | w g w |
| 9 | G 3 | – | W 1 | - | - | g r |
| 10 | W 3 | – | G 1 | - | - | r g |
| 11 | R 3 | W 2 | G 1 | - | - | w w g |

Distance 3,000 yards (with binoculars).

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 3 | W 2 | W 1 | - | - | correct. |
| 2 | G 3 | G 2 | W 1 | - | - | g g r |
| 3 | R 3 | – | R 1 | - | - | correct. |
| 4 | W 3 | – | G 1 | - | - | r g |
| 5 | W 3 | G 2 | G 1 | - | - | correct. |
| 6 | G 3 | R 2 | W 1 | - | - | g r r |
| 7 | R 3 | W 2 | G 1 | - | - | |
| 8 | G 3 | – | W 1 | - | - | correct. |
| 9 | W 3 | W 2 | G 1 | - | - | |
| 10 | R 3 | – | W 1 | - | - | r r |
| 11 | G 3 | – | R 1 | - | - | correct. |

Distance 2,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 3 | W 2 | W 1 | - | - | correct. |
| 2 | G 3 | R 2 | W 1 | - | - | g w w |
| 3 | R 3 | W 2 | G 1 | - | - | w w g |
| 4 | R 3 | G 2 | G 1 | - | - | w g g |
| 5 | W 3 | R 2 | G 1 | - | - | w w g |
| 6 | G 3 | – | R 1 | - | - | |
| 7 | G 3 | – | W 1 | - | - | correct. |
| 8 | R 3 | – | R 1 | - | - | |
| 9 | W 3 | – | R 1 | - | - | w w |
| 10 | G 3 | – | G I | - | - | g w |
| 11 | G 3 | W 2 | R 1 | - | - | correct. |

Distance 2,000 yards (with binoculars).

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 3 | W 2 | W 1 | - | - | |
| 2 | R 3 | – | R 1 | - | - | correct. |
| 3 | R 3 | W 2 | G 1 | - | - | w w g |
| 4 | R 3 | G 2 | G 1 | - | - | r g w |
| 5 | G 3 | – | R 1 | - | - | |
| 6 | G 3 | W 2 | R 1 | - | - | |
| 7 | G 3 | – | W 1 | - | - | correct. |
| 8 | G 3 | R 2 | W 1 | - | - | |
| 9 | G 3 | – | G 1 | - | - | |
| 10 | W 3 | R 2 | G 1 | - | - | w w g |
| 11 | W 3 | – | R 1 | - | - | correct. |

N

Distance 1,500 yards.

| Observation. | Lights shown. | | | | | Report. |
|---|---|---|---|---|---|---|
| 1 | W 3 | W 2 | W 1 | - | - | correct. |
| 2 | G 3 | – | G 1 | - | - | |
| 3 | G 3 | – | R 1 | - | - | |
| 4 | G 3 | R 2 | W 1 | - | - | g r g |
| 5 | G 3 | – | W 1 | - | - | correct. |
| 6 | G 3 | W 2 | R 1 | - | - | |
| 7 | R 3 | – | R 1 | - | - | r g |
| 8 | R 3 | G 2 | G 1 | - | - | correct. |
| 9 | R 3 | W 2 | G 1 | - | - | |
| 10 | W 3 | – | R 1 | - | - | r r |
| 11 | W 3 | R 2 | G 1 | - | - | correct. |

Distance 1,500 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 3 | W 2 | W 1 | - | - | |
| 2 | R 3 | W 2 | G 1 | - | - | |
| 3 | W 3 | R 2 | G 1 | - | - | |
| 4 | G 3 | – | W 1 | - | - | correct. |
| 5 | W 3 | – | R 1 | - | - | |
| 6 | G 3 | W 2 | R 1 | - | - | |
| 7 | G 3 | – | G 1 | - | - | |
| 8 | R 3 | – | R 1 | - | - | w r |
| 9 | G 3 | – | R 1 | - | - | correct. |
| 10 | R 3 | G 2 | G 1 | - | - | |
| 11 | G 3 | R 2 | W 1 | - | - | g r g |

Distance 1,500 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 3 | W 2 | W 1 | - | - | |
| 2 | G 3 | – | R 1 | - | - | correct. |
| 3 | W 3 | R 2 | G 1 | - | - | |
| 4 | R 3 | – | R 1 | - | - | correct.* |
| 5 | G 3 | R 2 | W 1 | - | - | g w w |
| 6 | G 3 | – | W 1 | - | - | |
| 7 | G 3 | W 2 | R 1 | - | - | |
| 8 | W 3 | – | R 1 | - | - | correct. |
| 9 | R 3 | G 2 | G 1 | - | - | |
| 10 | G 3 | – | G 1 | - | - | |
| 11 | R 3 | W 2 | G 1 | - | - | |

* First said w r.

OBSERVER No. 11.

Distance 3,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 3 | W 2 | W 1 | - | - | |
| 2 | W 3 | R 2 | G 1 | - | - | |
| 3 | W 3 | – | R 1 | - | - | correct. |
| 4 | R 3 | – | R 1 | - | - | |
| 5 | R 3 | W 2 | G 1 | - | - | |
| 6 | R 3 | G 2 | G 1 | - | - | |
| 7 | G 3* | R 2 | W 1 | - | - | r w |
| 8 | G 3* | – | R 1 | - | - | r |
| 9 | G 3* | – | G 1 | - | - | g |
| 10 | G 3* | – | W 1 | - | - | w |
| 11 | G 3* | W 2 | R 1 | - | - | w r |

* *See* note on p. .

Distance 3,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 3 | W 2 | W 1 | - | - | |
| 2 | W 3 | G 2 | R 1 | - | - | |
| 3 | G 3 | G 2 | G 1 | - | - | |
| 4 | R 3 | – | W 1 | - | - | |
| 5 | G 3 | G 2 | W 1 | - | - | correct. |
| 6 | G 3 | – | G 1 | - | - | |
| 7 | R 3 | – | W 1 | - | - | |
| 8 | R 3 | G 2 | W 1 | - | - | |
| 9 | G 3 | – | W 1 | - | - | |
| 10 | W 3 | – | G 1 | - | - | |
| 11 | R 3 | W 2 | G 1 | - | - | |

Distance 2,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 3 | W 2 | W 1 | - | - | |
| 2 | G 3 | R 2 | W 1 | - | - | |
| 3 | R 3 | W 2 | G 1 | - | - | |
| 4 | R 3 | G 2 | G 1 | - | - | |
| 5 | W 3 | R 2 | G 1 | - | - | correct. |
| 6 | G 3 | – | R 1 | - | - | |
| 7 | G 3 | – | W 1 | - | - | |
| 8 | R 3 | – | R 1 | - | - | |
| 9 | W 3 | – | R 1 | - | - | |
| 10 | G 3 | – | R 1 | - | - | |
| 11 | G 3 | W 2 | R 1 | - | - | |

Distance 1,500 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 3 | W 2 | W 1 | - | - | |
| 2 | G 3 | – | R 1 | - | - | |
| 3 | W 3 | R 2 | G 1 | - | - | |
| 4 | R 3 | – | R 1 | - | - | |
| 5 | G 3 | R 2 | W 1 | - | - | |
| 6 | G 3 | – | W 1 | - | - | correct. |
| 7 | G 3 | W 2 | R 1 | - | - | |
| 8 | W 3 | – | R 1 | - | - | |
| 9 | R 3 | G 2 | G 1 | - | - | |
| 10 | G 3 | – | G 1 | - | - | |
| 11 | R 3 | W 2 | G 1 | - | - | |

OBSERVER No. 12.

Distance 3,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 3 | W 2 | W 1 | - | - | |
| 2 | W 3 | R 2 | G 1 | - | - | |
| 3 | W 3 | • – | R 1 | - | - | correct. |
| 4 | R 3 | – | R 1 | - | - | |
| 5 | R 3 | W 2 | G 1 | - | - | |
| 6 | R 3 | G 2 | G 1 | - | - | |
| 7 | G 3* | R 2 | W 1 | - | - | r w |
| 8 | G 3* | – | R 1 | - | - | r |
| 9 | G 3* | – | G 1 | - | - | g g g |
| 10 | G 3* | – | W 1 | - | - | w |
| 11 | G 3* | W 2 | R 1 | - | - | w r |

* *See* note on p. 193.

Distance 3,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 3 | W 2 | W 1 | - | - | |
| 2 | W 3 | G 2 | R 1 | - | - | |
| 3 | G 3 | G 2 | G 1 | - | - | |
| 4 | R 3 | – | W 1 | - | - | |
| 5 | G 3 | G 2 | W 1 | - | - | |
| 6 | G 3 | – | G 1 | - | - | correct. |
| 7 | R 3 | – | W 1 | - | - | |
| 8 | R 3 | G 2 | W 1 | - | - | |
| 9 | G 3 | – | W 1 | - | - | |
| 10 | W 3 | – | G 1 | - | - | |
| 11 | R 3 | W 2 | G 1 | - | - | |

Distance 2,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 3 | W 2 | W 1 | - | - | |
| 2 | R 3 | – | R 1 | - | - | |
| 3 | R 3 | W 2 | G 1 | - | - | |
| 4 | R 3 | G 2 | G 1 | - | - | correct. |
| 5 | G 3 | – | R 1 | - | - | |
| 6 | G 3 | W 2 | R 1 | - | - | |
| 7 | G 3 | – | W 1 | - | - | |
| 8 | G 3 | R 2 | W 1 | - | - | r w |
| 9 | G 3 | – | G 1 | - | - | |
| 10 | W 3 | R 2 | G 1 | - | - | correct. |
| 11 | W 3 | – | R 1 | - | - | |



Distance 1,500 yards.

| Observation. | Lights shown. | | | | | Report. |
|---|---|---|---|---|---|---|
| 1 | W 3 | W 2 | W 1 | - | - | correct. |
| 2 | G 3 | – | G 1 | - | - | |
| 3 | G 3 | – | R 1 | - | - | |
| 4 | G 3 | R | W 1 | - | - | |
| 5 | G 3 | – | W 1 | - | - | |
| 6 | G 3 | W 2 | R 1 | - | - | |
| 7 | R 3 | – | R 1 | - | - | |
| 8 | R 3 | G 2 | G 1 | - | - | |
| 9 | R 3 | W 2 | G 1 | - | - | |
| 10 | W 3 | – | R 1 | - | - | |
| 11 | W 3 | R 2 | G 1 | - | - | |

OBSERVER No. 16.

Distance 3,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 3 | W 2 | W 1 | - | - | w w |
| 2 | G 3 | G 2 | W 1 | - | - | w g |
| 3 | R 3 | – | R 1 | - | - | correct. |
| 4 | W 3 | – | G 1 | - | - | |
| 5 | W 3 | G 2 | G 1 | - | - | g g |
| 6 | G 3 | R 2 | W 1 | - | - | r r |
| 7 | R 3 | W 2 | G 1 | - | - | w w g |
| 8 | G 3 | – | W 1 | - | - | g g |
| 9 | W 3 | W 2 | G 1 | - | - | w w |
| 10 | R 3 | – | W 1 | - | - | r r |
| 11 | G 3 | – | R 1 | - | - | correct. |

Distance, 2,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 3 | W 2 | W 1 | - | - | correct. |
| 2 | R 3 | – | R 1 | - | - | |
| 3 | R 3 | W 2 | G 1 | - | - | r w w |
| 4 | R 3 | G 2 | G 1 | - | - | correct. |
| 5 | G 3 | – | R 1 | - | - | |
| 6 | G 3 | W 2 | R 1 | - | - | w r |
| 7 | G 3 | – | W 1 | - | - | correct. |
| 8 | G 3 | R 2 | W 1 | - | - | r w |
| 9 | G 3 | – | G 1 | - | - | |
| 10 | W 3 | R 2 | G 1 | - | - | correct. |
| 11 | W 3 | – | R 1 | - | - | |

Distance 1,500 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 3 | W 2 | W 1 | - | - | |
| 2 | R 3 | W 2 | G 1 | - | - | |
| 3 | W 3 | R 2 | G 1 | - | - | |
| 4 | G 3 | – | W 1 | - | - | |
| 5 | W 3 | – | R 1 | - | - | |
| 6 | G 3 | W 2 | R 1 | - | - | correct. |
| 7 | G 3 | – | G 1 | - | - | |
| 8 | R 3 | – | R 1 | - | - | |
| 9 | G 3 | – | R 1 | - | - | |
| 10 | R 3 | G 2 | G 1 | - | - | |
| 11 | G 3 | R 2 | W 1 | - | - | |

FIFTH NIGHT—NOVEMBER 17TH.

Weather throughout fine and clear.

OBSERVER No. 10.

Distance 3,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 2 | W 3 | W 1 | - | - | correct. |
| 2 | W 2 | G 3 | R 1 | - | - | g r |
| 3 | G 2 | G 3 | G 1 | - | - | g g |
| 4 | R 2 | – | W 1 | - | - | w r |
| 5 | G 2 | G 3 | W 1 | - | - | g w |
| 6 | G 2 | – | G 1 | - | - | correct. |
| 7 | R 2 | – | W 1 | - | - | r g |
| 8 | R 2 | G 3 | W 1 | - | - | r r |
| 9 | G 2 | – | W 1 | - | - | correct. |
| 10 | W 2 | – | G 1 | - | - | |
| 11 | R 2 | W 3 | G 1 | - | - | w w g |

Distance 2,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 2 | W 3 | W 1 | - | - | |
| 2 | G 2 | – | W 1 | - | - | correct. |
| 3 | G 2 | – | G 1 | - | - | |
| 4 | R 2 | G 3 | G 1 | - | - | |
| 5 | W 2 | R 3 | G 1 | - | - | w w g |
| 6 | G 2 | W 3 | R 1 | - | - | g r w |
| 7 | G 2 | – | R 1 | - | - | g w |
| 8 | R 2 | W 3 | G 1 | - | - | |
| 9 | W 2 | – | R 1 | - | - | correct. |
| 10 | R 2 | – | R 1 | - | - | |
| 11 | G 2 | R 3 | W 1 | - | - | g w w |

Distance 1,000 yards.

| Observation. | Lights shown. | | | | | Report. |
|---|---|---|---|---|---|---|
| 1 | W 2 | W 3 | W 1 | - | - | correct. |
| 2 | W 2 | – | R 1 | - | - | |
| 3 | G 2 | – | R 1 | - | - | |
| 4 | R 2 | – | R 1 | - | - | |
| 5 | G 2 | W 3 | R 1 | - | - | |
| 6 | W 2 | R 3 | G 1 | - | - | |
| 7 | R 2 | W 3 | G 1 | - | - | |
| 8 | G 2 | – | G 1 | - | - | |
| 9 | R 2 | G 3 | G 1 | - | - | r g w |
| 10 | G 2 | R 3 | W 1 | - | - | correct. |
| 11 | G 2 | – | W 1 | - | - | |

Distance 1,000 yards (with binoculars).

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | G 2 | W 3 | G 1 | - | - | correct. |
| 2 | W 2 | – | R 1 | - | - | correct.* |
| 3 | R 2 | G 3 | G 1 | - | - | |
| 4 | G 2 | – | W 1 | - | - | |
| 5 | W 2 | W 3 | W 1 | - | - | |
| 6 | R 2 | W 3 | G 1 | - | - | correct |
| 7 | G 2 | – | G 1 | - | - | |
| 8 | G 2 | R 3 | W 1 | - | - | |
| 9 | W 2 | – | G 1 | - | - | |
| 10 | R 2 | R 3 | R 1 | - | - | |

* Second attempt. First said g r.

OBSERVER No. 11.

Distance 3,000 yards (with binoculars).

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 2 | W 3 | W 1 | - | - | |
| 2 | W 2 | G 3 | R 1 | - | - | |
| 3 | G 2 | G 3 | G 1 | - | - | |
| 4 | R 2 | – | W 1 | - | - | |
| 5 | G 2 | G 3 | W 1 | - | - | |
| 6 | G 2 | – | G 1 | - | - | correct. |
| 7 | R 2 | – | W 1 | - | - | |
| 8 | R 2 | G 3 | W 1 | - | - | |
| 9 | G 2 | – | W 1 | - | - | |
| 10 | W 2 | – | G 1 | - | - | |
| 11 | R 2 | W 3 | G 1 | - | - | r g g |

Distance 2,000 yards (with binoculars).

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 2 | W 3 | W 1 | - | - | |
| 2 | G 2 | – | W 1 | - | - | |
| 3 | G 2 | – | G 1 | - | - | |
| 4 | R 2 | G 3 | G 1 | - | - | |
| 5 | W 2 | R 3 | G 1 | - | - | |
| 6 | G 2 | W 3 | R 1 | - | - | correct. |
| 7 | G 2 | – | R 1 | - | - | |
| 8 | R 2 | W 3 | G 1 | - | - | |
| 9 | W 2 | – | R 1 | - | - | |
| 10 | R 2 | – | R 1 | - | - | |
| 11 | G 2 | R 3 | W 1 | - | - | |

OBSERVER No. 12.

Distance 3,000 yards (with binoculars).

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 2 | W 3 | W 1 | - | - | |
| 2 | W 2 | G 3 | R 1 | - | - | |
| 3 | G 2 | G 3 | G 1 | - | - | |
| 4 | R 2 | – | W 1 | - | - | |
| 5 | G 2 | G 3 | W 1 | - | - | |
| 6 | G 2 | – | G 1 | - | - | correct. |
| 7 | R 2 | – | W 1 | - | - | |
| 8 | R 2 | G 3 | W 1 | - | - | |
| 9 | G 2 | – | W 1 | - | - | |
| 10 | W 2 | – | G 1 | - | - | |
| 11 | R 2 | W 3 | G 1 | - | - | |

Distance 2,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 2 | W 3 | W 1 | - | - | |
| 2 | G 2 | – | W 1 | - | - | |
| 3 | G 2 | – | G 1 | - | - | |
| 4 | R 2 | G 3 | G 1 | - | - | |
| 5 | W 2 | R 3 | G 1 | - | - | |
| 6 | G 2 | W 3 | R 1 | - | - | correct. |
| 7 | G 2 | – | R 1 | - | - | |
| 8 | R 2 | W 3 | G 1 | - | - | |
| 9 | W 2 | – | R 1 | - | - | |
| 10 | R 2 | – | R 1 | - | - | |
| 11 | G 2 | R 3 | W 1 | - | - | |

OBSERVER No. 13.

Distance 3,000 yards.

| Observation. | Lights shown. | | | | | Report. |
|---|---|---|---|---|---|---|
| 1 | W 2 | W 3 | W 1 | - | - | correct. |
| 2 | W 2 | – | R 1 | - | - | w r r |
| 3 | G 2 | – | R 1 | - | - | correct. |
| 4 | R 2 | – | R 1 | - | - | |
| 5 | G 2 | W 3 | R 1 | - | - | r |
| 6 | W 2 | R 3 | G 1 | - | - | w |
| 7 | R 2 | W 3 | G 1 | - | - | r |
| 8 | G 2 | – | G 1 | - | - | correct. |
| 9 | R 2 | G 3 | G 1 | - | - | r r |
| 10 | G 2 | R 3 | W 1 | - | - | w w |
| 11 | G 2 | – | W 1 | - | - | w w |

Distance 3,000 yards (with binoculars).

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 2 | W 3 | W 1 | - | - | correct. |
| 2 | W 2 | R 3 | G 1 | - | - | |
| 3 | W 2 | – | R 1 | - | - | |
| 4 | R 2 | – | R 1 | - | - | |
| 5 | R 2 | W 3 | G 1 | - | - | |
| 6 | R 2 | G 3 | G 1 | - | - | r g |
| 7 | G 2 | R 3 | W 1 | - | - | correct. |
| 8 | G 2 | – | R 1 | - | - | |
| 9 | G 2 | – | G 1 | - | - | |
| 10 | G 2 | – | W 1 | - | - | |
| 11 | G 2 | W 3 | R 1 | - | - | |

Distance 2,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | G 2 | G 3 | R 1 | - | - | g r. |
| 2 | R 1 | – | R 2 | - | - | correct. |
| 3 | G 2 | – | W 1 | - | - | |
| 4 | G 2 | R 3 | G 1 | - | - | |
| 5 | W 2 | G 3 | W 1 | - | - | w w |
| 6 | R 2 | – | W 1 | - | - | correct. |
| 7 | G 2 | W 3 | W 1 | - | - | |
| 8 | R 2 | G 3 | W 1 | - | - | |
| 9 | W 2 | – | G 1 | - | - | |
| 10 | R 2 | R 3 | R 1 | - | - | |

Distance 2,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 2 | W 3 | R 1 | - | - | correct. |
| 2 | R 2 | – | G 1 | - | - | |
| 3 | G 2 | G 3 | R 1 | - | - | g r r. |
| 4 | G 2 | – | W 1 | - | - | g w w. |
| 5 | G 2 | R 3 | G 1 | - | - | correct. |
| 6 | R 2 | – | W 1 | - | - | |
| 7 | W 2 | R 3 | W 1 | - | - | |
| 8 | G 2 | – | G 1 | - | - | g |
| 9 | W 2 | G 3 | W 1 | - | - | w w w |
| 10 | R 2 | R 3 | R 1 | - | - | correct. |

Distance 1,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 2 | W 3 | W 1 | - | - | correct. |
| 2 | W 2 | – | R 1 | - | - | |
| 3 | G 2 | – | R 1 | - | - | |
| 4 | R 2 | – | R 1 | - | - | |
| 5 | G 2 | W 3 | R 1 | - | - | |
| 6 | W 2 | R 3 | G 1 | - | - | |
| 7 | R 2 | W 3 | G 1 | - | - | |
| 8 | G 2 | – | G 1 | - | - | |
| 9 | R 2 | G 3 | G 1 | - | - | r g. |
| 10 | G 2 | R 3 | W 1 | - | - | correct. |
| 11 | G 2 | – | W 1 | - | - | |

OBSERVER No. 14.

Distance 3,000 yards (with binoculars).

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 2 | W 3 | W 1 | - | - | correct. |
| 2 | W 2 | R 3 | G 1 | - | - | |
| 3 | W 2 | – | R 1 | - | - | |
| 4 | R 2 | – | R 1 | - | - | |
| 5 | R 2 | W 3 | G 1 | - | - | |
| 6 | R 2 | G 3 | G 1 | - | - | |
| 7 | G 2 | R 3 | W 1 | - | - | |
| 8 | G 2 | – | R 1 | - | - | |
| 9 | G 2 | – | G 1 | - | - | |
| 10 | G 2 | – | W 1 | - | - | |
| 11 | G 2 | W 3 | R 1 | - | - | |

Distance 2,000 yards (with binoculars).

| Observation. | Lights shown. | | | | | Report. |
|---|---|---|---|---|---|---|
| 1 | G 2 | G 3 | R 1 | - | - | g g w |
| 2 | R 2 | – | R 1 | - | - | correct. |
| 3 | G 2 | – | W 1 | - | - | |
| 4 | G 2 | R 3 | G 1 | - | - | |
| 5 | W 2 | G 3 | W 1 | - | - | |
| 6 | R 2 | – | W 1 | - | - | |
| 7 | G 2 | W 3 | W 1 | - | - | |
| 8 | R 2 | G 3 | W 1 | - | - | |
| 9 | W 2 | – | G 1 | - | - | |
| 10 | R 2 | R 3 | R 1 | - | - | |

OBSERVER No. 15.

Distance 3,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 2 | W 3 | W 1 | - | - | correct. |
| 2 | W 2 | R 3 | G 1 | - | - | |
| 3 | W 2 | – | R 1 | - | - | g r. |
| 4 | R 2 | – | R 1 | - | - | correct. |
| 5 | R 2 | W 3 | G 1 | - | - | r g g |
| 6 | R 2 | G 3 | G 1 | - | - | r g |
| 7 | G 2 | R 3 | W 1 | - | - | correct. |
| 8 | G 2 | – | R 1 | - | - | |
| 9 | G 2 | – | G 1 | - | - | |
| 10 | G 2 | – | W 1 | - | - | |
| 11 | G 2 | W 3 | R 1 | - | - | g g r. |

Distance 3,000 yards (with binoculars).

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 2 | W 3 | W 1 | - | - | correct. |
| 2 | W 2 | – | R 1 | - | - | |
| 3 | G 2 | – | R 1 | - | - | |
| 4 | R 2 | – | R 1 | - | - | |
| 5 | G 2 | W 3 | R 1 | - | - | |
| 6 | W 2 | R 3 | G 1 | - | - | |
| 7 | R 2 | W 3 | G 1 | - | - | |
| 8 | G 2 | – | G 1 | - | - | |
| 9 | R 2 | G 3 | G 1 | - | - | r g. |
| 10 | G 2 | R 3 | W 1 | - | - | correct. |
| 11 | G 2 | – | W 1 | - | - | |

Distance 2,000 yards (with binoculars).

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 2 | W 3 | R 1 | - | - | correct. |
| 2 | R 2 | – | G 1 | - | - | |
| 3 | G 2 | G 3 | R 1 | - | - | |
| 4 | G 2 | – | W 1 | - | - | |
| 5 | G 2 | R 3 | G 1 | - | - | |
| 6 | R 2 | – | W 1 | - | - | |
| 7 | W 2 | R 3 | W 1 | - | - | |
| 8 | G 2 | – | G 1 | - | - | |
| 9 | W 2 | G 3 | W 1 | - | - | |
| 10 | R 2 | R 3 | R 1 | - | - | |

Distance 2,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | G 2 | G 3 | R 1 | - | - | correct. |
| 2 | R 2 | – | R 1 | - | - | |
| 3 | G 2 | – | W 1 | - | - | |
| 4 | G 2 | R 3 | G 1 | - | - | |
| 5 | W 2 | G 3 | W 1 | - | - | |
| 6 | R 2 | – | W 1 | - | - | |
| 7 | G 2 | W 3 | W 1 | - | - | |
| 8 | R 2 | G 3 | W 1 | - | - | |
| 9 | W 2 | – | G 1 | - | - | |
| 10 | R 2 | R 3 | R 1 | - | - | |

Distance 1,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | G 2 | W 3 | G 1 | - | - | correct. |
| 2 | W 2 | – | R 1 | - | - | |
| 3 | R 2 | G 3 | G 1 | - | - | |
| 4 | G 2 | – | W 1 | - | - | |
| 5 | W 2 | W 3 | W 1 | - | - | correct. |
| 6 | R 2 | W 3 | G 1 | - | - | |
| 7 | G 2 | – | R 1 | - | - | |
| 8 | G 2 | R 3 | W 1 | - | - | |
| 9 | W 2 | – | G 1 | - | - | |
| 10 | R 2 | R 3 | R 1 | - | - | |



Distance 1,000 yards.

| Observation. | Lights shown. | | | | | Report. |
|---|---|---|---|---|---|---|
| 1 | W 2 | W 3 | W 1 | - | - | correct. |
| 2 | W 2 | – | R 1 | - | - | |
| 3 | G 2 | – | R 1 | - | - | |
| 4 | R 2 | – | R 1 | - | - | |
| 5 | G 2 | W 3 | R 1 | - | - | |
| 6 | W 2 | R 3 | G 1 | - | - | correct. |
| 7 | R 2 | W 3 | G 1 | - | - | |
| 8 | G 2 | – | G 1 | - | - | |
| 9 | R 2 | G 3 | G 1 | - | - | |
| 10 | G 2 | R 3 | W 1 | - | - | |
| 11 | G 2 | – | W 1 | - | - | |

OBSERVER No. 16.

Distance 3,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 2 | W 3 | W 1 | - | - | correct. |
| 2 | W 2 | – | R 1 | - | - | |
| 3 | G 2 | – | R 1 | - | - | |
| 4 | R 2 | – | R 1 | - | - | |
| 5 | G 2 | W 3 | R 1 | - | - | g r r |
| 6 | W 2 | R 3 | G 1 | - | - | w w |
| 7 | R 2 | W 3 | G 1 | - | - | correct. |
| 8 | G 2 | – | G 1 | - | - | |
| 9 | R 2 | G 3 | G 1 | - | - | r g |
| 10 | G 2 | R 3 | W 1 | - | - | correct. |
| 11 | G 2 | – | W 1 | - | - | |

Distance 2,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | G 2 | G 3 | R 1 | - | - | g r |
| 2 | G 2 | – | W 1 | - | - | correct. |
| 3 | G 2 | R 3 | G 1 | - | - | |
| 4 | R 2 | – | W 1 | - | - | |
| 5 | W 2 | R 3 | W 1 | - | - | |
| 6 | G 2 | – | G 1 | - | - | |
| 7 | W 2 | G 3 | W 1 | - | - | w w |
| 8 | R 2 | R 3 | R 1 | - | - | correct. |

SIXTH NIGHT—NOVEMBER 18TH.

Weather throughout exceptionally clear. It was raining when the observations at 3,000 yards and 1,000 yards were being taken, but fine at 2,000 yards.

OBSERVER No. 10.

Distance 3,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | - | - | correct. |
| 2 | G 1 | – | R 2 | - | - | |
| 3 | W 1 | R 3 | G 2 | - | - | w w g |
| 4 | R 1 | – | R 2 | - | - | w r |
| 5 | G 1 | R 3 | W 2 | - | - | g w w |
| 6 | G 1 | – | W 2 | - | - | g r |
| 7 | G 1 | W 3 | R 2 | - | - | g g r |
| 8 | W 1 | – | R 2 | - | - | g r |
| 9 | R 1 | G 3 | G 2 | - | - | correct. |
| 10 | G 1 | – | G 2 | - | - | |
| 11 | R 1 | W 3 | G 2 | - | - | w r g |

Distance 3,000 yards (with binoculars.)

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | - | - | correct. |
| 2 | R 1 | – | R 2 | - | - | |
| 3 | R 1 | W 3 | G 2 | - | - | |
| 4 | R 1 | G 3 | G 2 | - | - | |
| 5 | G 1 | – | R 2 | - | - | |
| 6 | G 1 | W 3 | R 2 | - | - | |
| 7 | G 1 | – | W 2 | - | - | |
| 8 | G 1 | R 3 | W 2 | - | - | g w w |
| 9 | G 1 | – | G 2 | - | - | correct. |
| 10 | W 1 | R 3 | G 2 | - | - | |
| 11 | W 1 | – | R 2 | - | - | |

Distance 2,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | - | - | correct. |
| 2 | G 1 | R 3 | W 2 | - | - | |
| 3 | R 1 | W 3 | G 2 | - | - | w w g |
| 4 | R 1 | G 3 | G 2 | - | - | correct. |
| 5 | W 1 | R 3 | G 2 | - | - | w w g |
| 6 | G 1 | – | R 2 | - | - | correct. |
| 7 | G 1 | – | W 2 | - | - | |
| 8 | R 1 | – | R 2 | - | - | |
| 9 | W 1 | – | R 2 | - | - | |
| 10 | G 1 | – | G 2 | - | - | |
| 11 | G 1 | W 3 | R 2 | - | - | |

Distance 1,000 yards.

| Observation. | Lights shown. | | | | | Report. |
|---|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | - | - | w g w |
| 2 | W 1 | – | R 2 | - | - | correct. |
| 3 | G 1 | – | R 2 | - | - | |
| 4 | R 1 | – | R 2 | - | - | w r |
| 5 | G 1 | W 3 | R 2 | - | - | correct. |
| 6 | W 1 | R 3 | G 2 | - | - | |
| 7 | R 1 | W 3 | G 2 | - | - | |
| 8 | G 1 | – | G 2 | - | - | |
| 9 | R 1 | G 3 | G 2 | - | - | |
| 10 | G 1 | R 3 | W 2 | - | - | |
| 11 | G 1 | – | W 2 | - | - | |

OBSERVER No. 11.

Distance 3,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | - | - | correct. |
| 2 | G 1 | – | R 2 | - | - | |
| 3 | W 1 | R 3 | G 3 | - | - | |
| 4 | R 1 | – | R 2 | - | - | |
| 5 | G 1 | R 3 | W 2 | - | - | |
| 6 | G 1 | – | W 2 | - | - | correct. |
| 7 | G 1 | W 3 | R 2 | - | - | |
| 8 | W 1 | – | R 2 | - | - | |
| 9 | R 1 | G 3 | G 2 | - | - | |
| 10 | G 1 | – | G 2 | - | - | |
| 11 | R 1 | W 3 | G 2 | - | - | |

Distance 3,000 yards (with binoculars).

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | - | - | correct. |
| 2 | R 1 | W 3 | G 2 | - | - | |
| 3 | W 1 | R 3 | G 2 | - | - | |
| 4 | G 1 | – | W 2 | - | - | |
| 5 | W 1 | – | R 2 | - | - | |
| 6 | G 1 | W 3 | R 2 | - | - | correct. |
| 7 | G 1 | – | G 2 | - | - | |
| 8 | R 1 | – | R 2 | - | - | |
| 9 | G 1 | – | R 2 | - | - | |
| 10 | R 1 | – | G 2 | - | - | |
| 11 | G 1 | R 3 | W 2 | - | - | |

Distance 2,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | - | - | correct. |
| 2 | G 1 | R 3 | W 2 | - | - | |
| 3 | R 1 | W 3 | G 2 | - | - | |
| 4 | R 1 | G 3 | G 2 | - | - | |
| 5 | W 1 | R 3 | G 2 | - | - | |
| 6 | G 1 | – | R 2 | - | - | correct. |
| 7 | G 1 | – | W 2 | - | - | |
| 8 | R 1 | – | R 2 | - | - | |
| 9 | W 1 | – | R 2 | - | - | |
| 10 | G 1 | – | G 2 | - | - | |
| 11 | G 1 | W 3 | R 2 | - | - | |

OBSERVER No. 12.

Distance 3,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | - | - | correct. |
| 2 | G 1 | – | R 2 | - | - | |
| 3 | W 1 | R 3 | G 2 | - | - | |
| 4 | R 1 | – | R 2 | - | - | |
| 5 | G 1 | R 3 | W 2 | - | - | |
| 6 | G 1 | – | W 2 | - | - | correct. |
| 7 | G 1 | W 3 | R 2 | - | - | |
| 8 | W 1 | – | R 2 | - | - | |
| 9 | R 1 | G 3 | G 2 | - | - | |
| 10 | G 1 | – | G 2 | - | - | |
| 11 | R 1 | W 3 | G 2 | - | - | |

Distance 2,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | - | - | correct. |
| 2 | G 1 | R 3 | W 2 | - | - | |
| 3 | R 1 | W 3 | G 2 | - | - | |
| 4 | R 1 | G 3 | G 2 | - | - | |
| 5 | W 1 | R 3 | G 2 | - | - | |
| 6 | G 1 | – | R 2 | - | - | correct. |
| 7 | G 1 | – | W 2 | - | - | |
| 8 | R 1 | – | R 2 | - | - | |
| 9 | W 1 | – | R 2 | - | - | |
| 10 | G 1 | – | G 2 | - | - | |
| 11 | G 1 | W 3 | R 2 | - | - | |

### Observer No. 13.

Distance 3,000 yards.

| Observation. | Lights shown. | | | | | Report. |
|---|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | - | - | correct. |
| 2 | R 1 | W 3 | G 2 | - | - | r r |
| 3 | W 1 | R 3 | G 2 | - | - | w w |
| 4 | G 1 | – | W 2 | - | - | correct. |
| 5 | W 1 | – | R 2 | - | - | g r r |
| 6 | G 1 | W 3 | R 2 | - | - | g r |
| 7 | G 1 | – | G 2 | - | - | correct. |
| 8 | R 1 | – | R 2 | - | - | w r |
| 9 | G 1 | – | R 2 | - | - | r r |
| 10 | R 1 | – | G 2 | - | - | correct. |
| 11 | G 1 | R 3 | W 2 | - | - | w w |

Distance 3,000 yards (with binoculars).

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 1 | – | W 2 | - | - | correct. |
| 2 | G 1 | – | G 2 | - | - | |
| 3 | G 1 | – | R 2 | - | - | |
| 4 | G 1 | – | W 2 | - | - | w w |
| 5 | G 1 | – | W 2 | - | - | correct. |
| 6 | G 1 | – | R 2 | - | - | |
| 7 | R 1 | – | R 2 | - | - | |
| 8 | R 1 | – | G 2 | - | - | |
| 9 | R 1 | – | G 2 | - | - | |
| 10 | W 1 | – | R 2 | - | - | |
| 11 | W 1 | – | G 2 | - | - | |

Distance 2,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | - | - | correct. |
| 2 | G 1 | G 3 | W 2 | - | - | g w w |
| 3 | R 1 | – | R 2 | - | - | correct. |
| 4 | W 1 | – | G 2 | - | - | |
| 5 | W 1 | G 3 | G 2 | - | - | |
| 6 | – | R 3 | W 2 | - | - | r w w |
| 7 | R 1 | W 3 | G 2 | - | - | correct. |
| 8 | G 1 | – | W 2 | - | - | |
| 9 | W 1 | W 3 | G 2 | - | - | |
| 10 | R 1 | – | W 2 | - | - | |
| 11 | G 1 | – | R 2 | - | - | g r w |

Distance 2,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | - | - | correct. |
| 2 | G 1 | – | W 2 | - | - | g w w |
| 3 | G 1 | – | G 2 | - | - | g g g |
| 4 | R 1 | G 3 | G 2 | - | - | correct. |
| 5 | W 1 | R 3 | G 2 | - | - | |
| 6 | G 1 | W 3 | R 2 | - | - | w r |
| 7 | G 1 | – | R 2 | - | - | r w* |
| 8 | R 1 | W 3 | G 2 | - | - | correct. |
| 9 | W 1 | – | R 2 | - | - | w r w |
| 10 | R 1 | – | R 2 | - | - | correct. |
| 11 | G 1 | R 3 | W 2 | - | - | r w g* |

* It will be observed that throughout this series this observer often reported an extra light to the right. In interpreting these combinations it has been assumed that he failed to see the G 1.

Distance 1,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | - | - | correct. |
| 2 | W 1 | – | R 2 | - | - | |
| 3 | G 1 | – | R 2 | - | - | |
| 4 | R 1 | – | R 2 | - | - | |
| 5 | G 1 | W 3 | R 2 | - | - | |
| 6 | W 1 | R 3 | G 2 | - | - | |
| 7 | R 1 | W 3 | G 2 | - | - | |
| 8 | G 1 | – | G 2 | - | - | |
| 9 | R 1 | G 3 | G 2 | - | - | |
| 10 | G 1 | R 3 | W 2 | - | - | |
| 11 | G 1 | – | W 2 | - | - | |

Distance 1,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | - | - | correct. |
| 2 | W 1 | R 3 | G 2 | - | - | |
| 3 | W 1 | – | R 2 | - | - | |
| 4 | R 1 | – | R 2 | - | - | |
| 5 | R 1 | W 3 | G 2 | - | - | |
| 6 | R 1 | G 3 | G 2 | - | - | |
| 7 | G 1 | R 3 | W 2 | - | - | |
| 8 | G 1 | – | R 2 | - | - | |
| 9 | G 1 | – | G 2 | - | - | |
| 10 | G 1 | – | W 2 | - | - | |
| 11 | G 1 | W 3 | R 2 | - | - | |

### Observer No. 14.

Distance 3,000 yards.

| Observation. | Lights shown. | | | | | Report. |
|---|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | - | - | |
| 2 | R 1 | W 3 | G 2 | - | - | |
| 3 | W 1 | R 3 | G 2 | - | - | correct. |
| 4 | G 1 | – | W 2 | - | - | |
| 5 | W 1 | – | R 2 | - | - | |
| 6 | G 1 | W 3 | R 2 | - | - | g r |
| 7 | G 1 | – | G 2 | - | - | |
| 8 | R 1 | – | R 2 | - | - | |
| 9 | G 1 | – | R 2 | - | - | correct. |
| 10 | R 1 | – | G 2 | - | - | |
| 11 | G 1 | R 3 | W 2 | - | - | g w |

Distance 3,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | - | - | |
| 2 | R 1 | – | R 2 | - | - | |
| 3 | R 1 | W 3 | G 2 | - | - | |
| 4 | R 1 | G 3 | G 2 | - | - | correct. |
| 5 | G 1 | – | R 2 | - | - | |
| 6 | G 1 | W 3 | R 2 | - | - | |
| 7 | G 1 | – | W 2 | - | - | |
| 8 | G 1 | R 3 | W 2 | - | - | r w |
| 9 | G 1 | – | G 2 | - | - | |
| 10 | W 1 | R 3 | G 2 | - | - | correct. |
| 11 | W 1 | – | R 2 | - | - | |

Distance 2,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | - | - | correct. |
| 2 | G 1 | G 3 | W 2 | - | - | g w |
| 3 | R 1 | – | R 2 | - | - | |
| 4 | W 1 | – | G 2 | - | - | |
| 5 | W 1 | G 3 | G 2 | - | - | |
| 6 | G 1 | R 3 | W 2 | - | - | |
| 7 | R 1 | W 3 | G 2 | - | - | correct. |
| 8 | G 1 | – | W 2 | - | - | |
| 9 | W 1 | W 3 | G 2 | - | - | |
| 10 | R 1 | – | W 2 | - | - | |
| 11 | G 1 | – | R 2 | - | - | |

### Observer No. 15.

Distance 3,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 1 | – | W 2 | - | - | w g |
| 2 | G 1 | – | G 2 | - | - | |
| 3 | G 1 | – | R 2 | - | - | |
| 4 | G 1 | – | W 2 | - | - | |
| 5 | G 1 | – | W 2 | - | - | |
| 6 | G 1 | – | R 2 | - | - | correct. |
| 7 | R 1 | – | R 2 | - | - | |
| 8 | R 1 | – | G 2 | - | - | |
| 9 | R 1 | – | G 2 | - | - | |
| 10 | W 1 | – | R 2 | - | - | |
| 11 | W 1 | – | G 2 | - | - | |

Distance 3,000 yards (with binoculars).

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | - | - | |
| 2 | R 1 | – | R 2 | - | - | |
| 3 | R 1 | W 3 | G 2 | - | - | |
| 4 | R 1 | G 3 | G 2 | - | - | |
| 5 | G 1 | – | R 2 | - | - | |
| 6 | G 1 | W 3 | R 2 | - | - | correct |
| 7 | G 1 | – | W 2 | - | - | |
| 8 | G 1 | R 3 | W 2 | - | - | |
| 9 | G 1 | – | G 2 | - | - | |
| 10 | W 1 | R 3 | G 2 | - | - | |
| 11 | W 1 | – | R 2 | - | - | |

Distance 2,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | - | - | |
| 2 | G 1 | – | W 2 | - | - | |
| 3 | G 1 | – | G 2 | - | - | |
| 4 | R 1 | G 3 | G 2 | - | - | |
| 5 | W 1 | R 3 | G 2 | - | - | |
| 6 | G 1 | W 3 | R 2 | - | - | correct. |
| 7 | G 1 | – | R 2 | - | - | |
| 8 | R 1 | W 3 | G 2 | - | - | |
| 9 | W 1 | – | R 2 | - | - | |
| 10 | R 1 | – | R 2 | - | - | |
| 11 | G 1 | R 3 | W 2 | - | - | |



Distance 1,000 yards.

| Observation. | Light shown. | | | | | Report. |
|---|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | - | - | |
| 2 | W 1 | – | R 2 | - | - | |
| 3 | G 1 | – | R 2 | - | - | |
| 4 | R 1 | – | R 2 | - | - | |
| 5 | G 1 | W 3 | R 2 | - | - | |
| 6 | W 1 | R 3 | G 2 | - | - | correct. |
| 7 | R 1 | W 3 | G 2 | - | - | |
| 8 | G 1 | – | G 2 | - | - | |
| 9 | R 1 | G 3 | G 2 | - | - | |
| 10 | G 1 | R 3 | W 2 | - | - | |
| 11 | G 1 | – | W 2 | - | - | |

Distance 1;000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | - | - | |
| 2 | W 1 | R 3 | G 2 | - | - | |
| 3 | W 1 | – | R 2 | - | - | |
| 4 | R 1 | – | R 2 | - | - | |
| 5 | R 1 | W 3 | G 2 | - | - | |
| 6 | R 1 | G 3 | G 2 | - | - | correct. |
| 7 | G 1 | R 3 | W 2 | - | - | |
| 8 | G 1 | – | R 2 | - | - | |
| 9 | G 1 | – | G 2 | - | - | |
| 10 | G 1 | – | W 2 | - | - | |
| 11 | G 1 | W 3 | R 2 | - | - | |

### Observer No. 16.

Distance 3,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 1 | – | W 2 | - | - | g w |
| 2 | G 1 | – | G 2 | - | - | |
| 3 | G 1 | – | R 2 | - | - | correct. |
| 4 | G 1 | – | W 2 | - | - | w w |
| 5 | G 1 | – | W 2 | - | - | |
| 6 | G 1 | – | R 2 | - | - | |
| 7 | R 1 | – | R 2 | - | - | correct. |
| 8 | R 1 | – | G 2 | - | - | |
| 9 | R 1 | – | G 2 | - | - | r w |
| 10 | W 1 | – | R 2 | - | - | correct. |
| 11 | W 1 | – | G 2 | - | - | w w |

Distance 2,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | - | - | |
| 2 | G 1 | G 3 | W 2 | - | - | |
| 3 | R 1 | – | R 2 | - | - | |
| 4 | W 1 | – | G 2 | - | - | correct. |
| 5 | W 1 | G 3 | G 2 | - | - | |
| 6 | – | R 3 | W 2 | - | - | |
| 7 | R 1 | W 3 | G 2 | - | - | r g g |
| 8 | G 1 | – | W 2 | - | - | |
| 9 | W 1 | W 3 | G 2 | - | - | correct. |
| 10 | R 1 | – | W 2 | - | - | |
| 11 | G 1 | – | R 2 | - | - | |

SEVENTH NIGHT—NOVEMBER 20TH.

Fine and clear throughout.

### Observer No. 10.

Distance 3,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | - | - | |
| 2 | G 1 | – | R 3 | - | - | correct. |
| 3 | W 1 | R 2 | G 3 | - | - | |
| 4 | R 1 | – | R 3 | - | - | g r |
| 5 | G 1 | R 2 | W 3 | - | - | |
| 6 | G 1 | – | W 3 | - | - | correct. |
| 7 | G 1 | W 2 | R 3 | - | - | |
| 8 | W 1 | – | R 3 | - | - | w w |
| 9 | R 1 | G 2 | G 3 | - | - | |
| 10 | G 1 | – | G 3 | - | - | correct. |
| 11 | R 1 | W 2 | G 3 | - | - | w w g |

Distance 2,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | - | - | |
| 2 | G 1 | – | G 3 | - | - | |
| 3 | G 1 | – | R 3 | - | - | |
| 4 | G 1 | R 2 | W 3 | - | - | correct. |
| 5 | G 1 | – | W 3 | - | - | |
| 6 | G 1 | W 2 | R 3 | - | - | |
| 7 | R 1 | – | R 3 | - | - | g r |
| 8 | R 1 | G 2 | G 3 | - | - | w g g |
| 9 | R 1 | W 2 | G 3 | - | - | r w w |
| 10 | W 1 | – | R 3 | - | - | r r |
| 11 | W 1 | R 2 | G 3 | - | - | correct. |

### Observer No. 13.

Distance 3,000 yards.

| Observation. | Lights shown. | | | | | Report. |
|---|---|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | - | - | correct. |
| 2 | G 1 | – | R 3 | - | - | g r r |
| 3 | W 1 | R 2 | G 3 | - | - | w r r |
| 4 | R 1 | – | R 3 | - | - | correct. |
| 5 | G 1 | R 2 | W 3 | - | - | w r w |
| 6 | G 1 | – | W 3 | - | - | r w |
| 7 | G 1 | W 2 | R 3 | - | - | correct. |
| 8 | W 1 | – | R 3 | - | - | w w r |
| 9 | R 1 | G 2 | G 3 | - | - | w w g |
| 10 | G 1 | – | G 3 | - | - | correct. |
| 11 | R 1 | W 2 | G 3 | - | - | g r w |

Distance 2,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | - | - | correct. |
| 2 | G 1 | – | G 3 | - | - | g g g |
| 3 | G 1 | – | R 3 | - | - | g r r |
| 4 | G 1 | R 2 | W 3 | - | - | w r g |
| 5 | G 1 | – | W 3 | - | - | g w g |
| 6 | G 1 | W 2 | R 3 | - | - | w w r |
| 7 | R 1 | – | R 3 | - | - | |
| 8 | R 1 | G 2 | G 3 | - | - | correct. |
| 9 | R 1 | W 2 | G 3 | - | - | |
| 10 | W 1 | – | R 3 | - | - | w g r |
| 11 | W 1 | R 2 | G 3 | - | - | w r w |

### Observer No. 14.

Distance 3,000 yards (with binoculars).

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | - | - | |
| 2 | W 1 | G 2 | R 3 | - | - | |
| 3 | G 1 | G 2 | G 3 | - | - | |
| 4 | R 1 | – | W 3 | - | - | correct. |
| 5 | G 1 | G 2 | W 3 | - | - | |
| 6 | G 1 | – | G 3 | - | - | |
| 7 | R 1 | – | W 3 | - | - | r g |
| 8 | R 1 | G 2 | W 3 | - | - | |
| 9 | G 1 | – | W 3 | - | - | correct. |
| 10 | W 1 | – | G 3 | - | - | |
| 11 | R 1 | W 2 | G 3 | - | - | |

Distance 3,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | - | - | correct. |
| 2 | R 1 | W 2 | G 3 | - | - | |
| 3 | W 1 | R 2 | G 3 | - | - | g r |
| 4 | G 1 | – | W 3 | - | - | |
| 5 | W 1 | – | R 3 | - | - | |
| 6 | G 1 | W 2 | R 3 | - | - | correct. |
| 7 | G 1 | – | G 3 | - | - | |
| 8 | R 1 | – | R 3 | - | - | |
| 9 | G 1 | – | R 3 | - | - | g r g |
| 10 | R 1 | G 2 | G 3 | - | - | correct. |
| 11 | G 1 | R 2 | W 3 | - | - | r w |

Distance 2,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | - | - | |
| 2 | W 1 | R 2 | G 3 | - | - | |
| 3 | W 1 | – | R 3 | - | - | |
| 4 | R 1 | – | R 3 | - | - | |
| 5 | R 1 | W 2 | G 3 | - | - | |
| 6 | R 1 | G 2 | G 3 | - | - | correct. |
| 7 | G 1 | R 2 | W 3 | - | - | |
| 8 | G 1 | – | R 3 | - | - | |
| 9 | G 1 | – | G 3 | - | - | |
| 10 | G 1 | – | W 3 | - | - | |
| 11 | G 1 | W 2 | R 3 | - | - | |

Distance 2,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | - | - | |
| 2 | W 1 | – | R 3 | - | - | |
| 3 | G 1 | – | R 3 | - | - | |
| 4 | R 1 | – | R 3 | - | - | correct. |
| 5 | G 1 | W 2 | R 3 | - | - | |
| 6 | W 1 | R 2 | G 3 | - | - | |
| 7 | R 1 | W 2 | G 3 | - | - | |
| 8 | R 1 | G 2 | G 3 | - | - | g g g |
| 9 | R 1 | G 2 | G 3 | - | - | |
| 10 | G 1 | R 2 | W 3 | - | - | correct. |
| 11 | G 1 | – | W 3 | - | - | |

### Observer No. 15.

Distance 3,000 yards.

| Observation. | Lights shown. | | | | | Report. |
|---|---|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | - | - | correct. |
| 2 | G 1 | – | R 3 | - | - | |
| 3 | W 1 | R 2 | G 3 | - | - | |
| 4 | R 1 | – | R 3 | - | - | |
| 5 | G 1 | R 2 | W 3 | - | - | |
| 6 | G 1 | – | W 3 | - | - | |
| 7 | G 1 | W 2 | R 3 | - | - | g r* |
| 8 | W 1 | – | R 3 | - | - | correct. |
| 9 | R 1 | G 2 | G 3 | - | - | |
| 10 | G 1 | – | G 3 | - | - | |
| 11 | R 1 | W 2 | G 3 | - | - | |

* It has been assumed that the observer here failed to see the red light, and mistook the white (electric) light for red.

Distance 3,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | - | - | correct. |
| 2 | W 1 | G 2 | R 3 | - | - | |
| 3 | G 1 | G 2 | G 3 | - | - | |
| 4 | R 1 | – | W 3 | - | - | |
| 5 | G 1 | G 2 | W 3 | - | - | |
| 6 | G 1 | – | G 3 | - | - | |
| 7 | R 1 | – | W 3 | - | - | r g |
| 8 | R 1 | G 2 | W 3 | - | - | correct. |
| 9 | G 1 | – | W 3 | - | - | |
| 10 | W 1 | – | G 3 | - | - | |
| 11 | R 1 | W 2 | G 3 | - | - | |

Distance 3,000 yards (with binoculars).

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | - | - | correct. |
| 2 | R 1 | W 2 | G 3 | - | - | |
| 3 | W 1 | R 2 | G 3 | - | - | w r |
| 4 | G 1 | – | W 3 | - | - | |
| 5 | W 1 | – | R 3 | - | - | correct. |
| 6 | G 1 | W 2 | R 3 | - | - | |
| 7 | G 1 | – | G 3 | - | - | g g g |
| 8 | R 1 | – | R 3 | - | - | |
| 9 | G 1 | – | R 3 | - | - | correct. |
| 10 | R 1 | G 2 | G 3 | - | - | |
| 11 | G 1 | R 2 | W 3 | - | - | |

Distance 2,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | - | - | correct. |
| 2 | G 1 | – | G 3 | - | - | |
| 3 | G 1 | – | R 3 | - | - | |
| 4 | G 1 | R 2 | W 3 | - | - | |
| 5 | G 1 | – | W 3 | - | - | |
| 6 | G 1 | W 2 | R 3 | - | - | |
| 7 | R 1 | – | R 3 | - | - | |
| 8 | R 1 | G 2 | G 3 | - | - | |
| 9 | R 1 | W 2 | G 3 | - | - | |
| 10 | W 1 | – | R 3 | - | - | |
| 11 | W 1 | R 2 | G 3 | - | - | |

Distance 2,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | - | - | correct. |
| 2 | W 1 | R 2 | G 3 | - | - | |
| 3 | W 1 | – | R 3 | - | - | |
| 4 | R 1 | – | R 3 | - | - | |
| 5 | G 1 | G 2 | W 3 | - | - | |
| 6 | G 1 | – | G 3 | - | - | |
| 7 | G 1 | R 2 | W 3 | - | - | |
| 8 | G 1 | – | R 3 | - | - | |
| 9 | G 1 | – | W 3 | - | - | |
| 10 | W 1 | – | G 3 | - | - | |
| 11 | R 1 | W 2 | G 3 | - | - | |

Distance 2,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | - | - | correct. |
| 2 | G 1 | – | G 3 | - | - | |
| 3 | G 1 | – | R 3 | - | - | |
| 4 | G 1 | R 2 | W 3 | - | - | |
| 5 | G 1 | – | W 3 | - | - | |
| 6 | G 1 | W 2 | R 3 | - | - | |
| 7 | R 1 | – | R 3 | - | - | |
| 8 | R 1 | G 2 | G 3 | - | - | |
| 9 | R 1 | W 2 | G 3 | - | - | |
| 10 | W 1 | – | R 3 | - | - | |
| 11 | W 1 | R 2 | G 3 | - | - | |

Distance 2,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | - | - | correct. |
| 2 | W 1 | R 2 | G 3 | - | - | |
| 3 | W 1 | – | R 3 | - | - | |
| 4 | R 1 | – | R 3 | - | - | |
| 5 | R 1 | W 2 | G 3 | - | - | |
| 6 | R 1 | G 2 | G 3 | - | - | |
| 7 | G 1 | R 2 | W 3 | - | - | |
| 8 | G 1 | – | R 3 | - | - | |
| 9 | G 1 | – | G 3 | - | - | |
| 10 | G 1 | – | W 3 | - | - | |
| 11 | G 1 | W 2 | R 3 | - | - | |

Distance 2,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | - | - | correct. |
| 2 | W 1 | – | R 3 | - | - | |
| 3 | G 1 | – | R 3 | - | - | |
| 4 | R 1 | – | R 3 | - | - | |
| 5 | G 1 | W 2 | R 3 | - | - | |
| 6 | W 1 | R 2 | G 3 | - | - | |
| 7 | R 1 | W 2 | G 3 | - | - | |
| 8 | G 1 | – | G 3 | - | - | |
| 9 | R 1 | G 2 | G 3 | - | - | |
| 10 | G 1 | R 2 | W 3 | - | - | |
| 11 | G 1 | – | W 3 | - | - | |

### Observer No. 16.

Distance 3,000 yards (with binoculars).

| Observation. | Lights shown. | | | | | Report. |
|---|---|---|---|---|---|---|
| 1 | W 1 | G 2 | R 3 | - | - | correct. |
| 2 | G 1 | G 2 | G 3 | - | - | |
| 3 | R 1 | – | W 3 | - | - | |
| 4 | G 1 | G 2 | W 3 | - | - | |
| 5 | G 1 | – | G 3 | - | - | |
| 6 | R 1 | – | W 3 | - | - | r g |
| 7 | R 1 | G 2 | W 3 | - | - | correct. |
| 8 | G 1 | – | W 3 | - | - | |
| 9 | W 1 | – | G 3 | - | - | |
| 10 | R 1 | W 2 | G 3 | - | - | |

Distance 3,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | - | - | correct. |
| 2 | R 1 | W 2 | G 3 | - | - | r w |
| 3 | W 1 | R 2 | G 3 | - | - | w r |
| 4 | G 1 | – | W 3 | - | - | correct. |
| 5 | W 1 | – | R 3 | - | - | |
| 6 | G 1 | W 2 | R 3 | - | - | g w w |
| 7 | G 1 | – | G 3 | - | - | correct. |
| 8 | R 1 | – | R 3 | - | - | |
| 9 | G 1 | – | R 3 | - | - | |
| 10 | R 1 | G 2 | G 3 | - | - | r g |
| 11 | G 1 | R 2 | W 3 | - | - | g r r |

Distance 2,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | - | - | correct. |
| 2 | W 1 | R 2 | G 3 | - | - | |
| 3 | W 1 | – | R 3 | - | - | |
| 4 | R 1 | – | R 3 | - | - | |
| 5 | R 1 | W 2 | G 3 | - | - | |
| 6 | R 1 | G 2 | G 3 | - | - | |
| 7 | G 1 | R 2 | W 3 | - | - | r w |
| 8 | G 1 | – | R 3 | - | - | correct. |
| 9 | G 1 | – | G 3 | - | - | g g g |
| 10 | G 1 | – | W 3 | - | - | correct. |
| 11 | G 1 | W 2 | R 3 | - | - | |

Distance 2,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | - | - | correct. |
| 2 | W 1 | – | R 3 | - | - | |
| 3 | G 1 | – | R 3 | - | - | |
| 4 | R 1 | – | R 3 | - | - | |
| 5 | G 1 | W 2 | R 3 | - | - | |
| 6 | W 1 | R 2 | G 3 | - | - | |
| 7 | R 1 | W 2 | G 3 | - | - | w r |
| 8 | G 1 | – | G 3 | - | - | |
| 9 | R 1 | G 2 | G 3 | - | - | correct. |
| 10 | G 1 | R 2 | W 3 | - | - | r w |
| 11 | G 1 | – | W 3 | - | - | g g w |

### EIGHTH NIGHT—NOVEMBER 21st.

There was a slight haze while the observations at 3,000 yards were taken, but the lights were just visible. They were easily seen at the shorter distances.

### Observer No. 10.

Distance 3,000 yards (with binoculars).

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | R 2 | – | W 1 | - | - | correct. |
| 2 | – | – | R 1 | - | - | |
| 3 | G 2 | – | R 1 | - | - | |
| 4 | – | – | G 1 | - | - | |
| 5 | W 2 | – | W 1 | - | - | |
| 6 | W 2 | – | G 1 | - | - | |
| 7 | W 2 | R 3 | – | - | - | |
| 8 | W 2 | G 3 | – | - | - | |
| 9 | G 2 | – | W 1 | - | - | |
| 10 | R 2 | – | G 1 | - | - | |
| 11 | G 2 | – | R 1 | - | - | g w |



Distance 2,000 yards.

| Observation. | Lights shown. | | | | | Report. |
|---|---|---|---|---|---|---|
| 1 | R 2 | R 3 | W 1 | - | - | r r g |
| 2 | G 2 | – | – | - | - | |
| 3 | G 2 | – | W 1 | - | - | correct |
| 4 | – | W 3 | – | - | - | |
| 5 | R 2 | W 3 | W 1 | - | - | r g g |
| 6 | G 2 | R 3 | G 1 | - | - | |
| 7 | – | – | G 1 | - | - | |
| 8 | R 2 | – | W 1 | - | - | correct. |
| 9 | – | – | G 1 | - | - | |
| 10 | – | W 3 | – | - | - | |
| 11 | G 2 | R 3 | R 1 | - | - | g r w |

Distance 1,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 2 | – | G 1 | - | - | correct. |
| 2 | W 2 | R 3 | G 1 | - | - | |
| 3 | R 2 | W 3 | G 1 | - | - | |
| 4 | G 2 | – | – | - | - | |
| 5 | – | W 3 | – | - | - | |
| 6 | G 2 | R 3 | G 1 | - | - | |
| 7 | G 2 | W 3 | R 1 | - | - | |
| 8 | R 2 | W 3 | W 1 | - | - | |
| 9 | G 2 | – | W 1 | - | - | |
| 10 | W 2 | – | G 1 | - | - | |
| 11 | G 2 | G 3 | W 1 | - | - | |

### Observer No. 11.

Distance 3,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | R 2 | – | W 1 | - | - | correct. |
| 2 | – | – | R 1 | - | - | |
| 3 | G 2 | – | R 1 | - | - | |
| 4 | – | – | G 1 | - | - | |
| 5 | W 2 | – | W 1 | - | - | |
| 6 | W 2 | – | G 1 | - | - | |
| 7 | W 2 | R 3 | – | - | - | w w |
| 8 | W 2 | G 3 | – | - | - | correct. |
| 9 | G 2 | – | W 1 | - | - | |
| 10 | R 2 | – | G 1 | - | - | w g |
| 11 | G 2 | – | R 1 | - | - | correct. |

Distance 3,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | R 2 | W 3 | R 1 | - | - | w w w |
| 2 | G 2 | – | G 1 | - | - | correct. |
| 3 | G 2 | – | R 1 | - | - | |
| 4 | W 2 | – | – | - | - | r |
| 5 | – | W 3 | – | - | - | |
| 6 | – | – | W 1 | - | - | |
| 7 | G 2 | – | W 1 | - | - | correct. |
| 8 | R 2 | R 3 | G 1 | - | - | |
| 9 | – | G 3 | – | - | - | |
| 10 | R 2 | – | W 1 | - | - | r r |
| 11 | G 2 | R 3 | W 1 | - | - | g r r |

Distance 3,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 2 | R 3 | R 1 | - | - | correct. |
| 2 | W 2 | – | G 1 | - | - | w g g |
| 3 | W 2 | – | R 1 | - | - | correct. |
| 4 | – | G 3 | – | - | - | |
| 5 | R 2 | W 3 | G 1 | - | - | w w g |
| 6 | W 2 | G 3 | W 1 | - | - | w g r |
| 7 | – | R 3 | – | - | - | correct. |
| 8 | – | – | W 1 | - | - | r |
| 9 | G 2 | – | – | - | - | correct. |
| 10 | R 2 | W 3 | R 1 | - | - | r r r |

Distance 2,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | R 2 | R 3 | W 1 | - | - | correct. |
| 2 | G 2 | – | – | - | - | |
| 3 | G 2 | – | W 1 | - | - | |
| 4 | – | W 3 | – | - | - | |
| 5 | R 2 | W 3 | W 1 | - | - | |
| 6 | G 2 | R 3 | G 1 | - | - | correct. |
| 7 | – | – | W 1 | - | - | |
| 8 | R 2 | R 3 | G 1 | - | - | |
| 9 | – | G 3 | – | - | - | |
| 10 | – | W 3 | – | - | - | |
| 11 | G 2 | R 3 | R 1 | - | - | |

Distance 2,000 yards.

| Observation. | Lights shown. | | | | | Report. |
|---|---|---|---|---|---|---|
| 1 | W 2 | – | R 1 | - | - | correct. |
| 2 | W 2 | W 3 | R 1 | - | - | |
| 3 | G 2 | – | – | - | - | |
| 4 | G 2 | R 3 | – | - | - | |
| 5 | R 2 | G 3 | W 1 | - | - | |
| 6 | – | G 3 | – | - | - | |
| 7 | G 2 | – | W 1 | - | - | |
| 8 | R 2 | – | W 1 | - | - | |
| 9 | – | W 3 | – | - | - | |
| 10 | – | – | G 1 | - | - | |
| 11 | G 2 | – | G 1 | - | - | |

Distance 1,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 2 | – | G 1 | - | - | correct |
| 2 | W 2 | R 3 | G 1 | - | - | |
| 3 | R 2 | W 3 | G 1 | - | - | |
| 4 | G 2 | – | – | - | - | |
| 5 | – | W 3 | – | - | - | |
| 6 | G 2 | R 3 | G 1 | - | - | |
| 7 | G 2 | W 3 | R 1 | - | - | |
| 8 | R 2 | W 3 | W 1 | - | - | |
| 9 | G 2 | – | W 1 | - | - | |
| 10 | W 2 | – | G 1 | - | - | |
| 11 | G 2 | G 3 | W 1 | - | - | |

### Observer No. 13.

Distance 1,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 2 | – | G 1 | - | - | correct. |
| 2 | W 2 | R 3 | G 1 | - | - | |
| 3 | R 2 | W 3 | G 1 | - | - | |
| 4 | G 2 | – | – | - | - | |
| 5 | – | W 3 | – | - | - | |
| 6 | G 2 | R 3 | G 1 | - | - | |
| 7 | G 2 | W 3 | R 1 | - | - | |
| 8 | R 2 | W 3 | W 1 | - | - | |
| 9 | G 2 | – | W 1 | - | - | |
| 10 | W 2 | – | G 1 | - | - | |
| 11 | G 2 | G 3 | W 1 | - | - | |

Distance 1,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 2 | R 3 | R 1 | - | - | correct. |
| 2 | – | W 3 | – | - | - | |
| 3 | W 2 | – | G 1 | - | - | |
| 4 | W 2 | – | R 1 | - | - | |
| 5 | – | G 3 | – | - | - | |
| 6 | R 2 | W 3 | G 1 | - | - | |
| 7 | W 2 | G 3 | W 1 | - | - | |
| 8 | – | – | R 1 | - | - | |
| 9 | – | – | – | - | - | |
| 10 | G 2 | – | – | - | - | |
| 11 | R 2 | W 3 | R 1 | - | - | |

### Observer No. 14.

Distance 3,000 yards (with binoculars).

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 2 | R 3 | R 1 | - | - | correct. |
| 2 | W 2 | – | G 1 | - | - | |
| 3 | W 2 | – | R 1 | - | - | |
| 4 | – | G 3 | – | - | - | |
| 5 | R 2 | W 3 | G 1 | - | - | |
| 6 | W 2 | G 3 | W 1 | - | - | |
| 7 | – | R 3 | – | - | - | r g |
| 8 | – | – | W 1 | - | - | correct. |
| 9 | G 2 | – | – | - | - | |
| 10 | R 2 | W 3 | R I | - | - | |

Distance 2,000 yards.

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | W 2 | – | R 1 | - | - | correct. |
| 2 | W 2 | W 3 | R 1 | - | - | |
| 3 | G 2 | – | – | - | - | |
| 4 | G 2 | R 3 | – | - | - | |
| 5 | R 2 | G 3 | W 1 | - | - | r w |
| 6 | – | G 3 | – | - | - | |
| 7 | G 2 | – | W 1 | - | - | correct. |
| 8 | R 2 | – | W 1 | - | - | |
| 9 | – | W 3 | – | - | - | |
| 10 | – | – | G 1 | - | - | |
| 11 | G 2 | – | G 1 | - | - | |

Distance 1,000 yards.

| Observation. | Lights shown. | | | | Report. |
|---|---|---|---|---|---|
| 1 | W 2 | R 3 | R 1 | - | } correct. |
| 2 | – | W 3 | – | - | |
| 3 | W 2 | – | G 1 | - | |
| 4 | W 2 | – | R 1 | - | |
| 5 | – | G 3 | – | - | |
| 6 | R 2 | W 3 | G 1 | - | |
| 7 | W 2 | G 3 | W 1 | - | |
| 8 | – | R 3 | – | - | |
| 9 | – | – | W 1 | - | |
| 10 | G 2 | – | – | - | |
| 11 | R 2 | W 3 | R 1 | - | |

OBSERVER No. 15.

Distance 3,000 yards (with binoculars).

| | | | | | |
|---|---|---|---|---|---|
| 1 | R 2 | – | W 1 | - | } correct. |
| 2 | – | – | R 1 | - | |
| 3 | G 2 | – | R 1 | - | |
| 4 | – | – | G 1 | - | |
| 5 | W 2 | – | W 1 | - | |
| 6 | W 2 | – | G 1 | - | |
| 7 | W 2 | R 3 | – | - | |
| 8 | W 2 | G 3 | – | - | |
| 9 | G 2 | – | W 1 | - | |
| 10 | R 2 | – | G 1 | - | |
| 11 | G 2 | – | R 1 | - | |

Distance 3,000 yards (with binoculars).

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 2 | R 3 | R 1 | - | } correct. |
| 2 | W 2 | – | G 1 | - | |
| 3 | W 2 | – | R 1 | - | |
| 4 | – | G 3 | – | - | |
| 5 | R 2 | W 3 | G 1 | - | |
| 6 | W 2 | G 3 | W 1 | - | |
| 7 | – | R 3 | – | - | |
| 8 | – | – | W 1 | - | |
| 9 | G 2 | – | – | - | |
| 10 | R 2 | W 3 | R 1 | - | |

Distance 3,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | R 2 | W 3 | R 1 | - | r r r |
| 2 | G 2 | – | G 1 | - | g g g |
| 3 | G 2 | – | R 1 | - | g r g |
| 4 | W 2 | – | – | - | w g |
| 5 | – | W 3 | – | - | w g |
| 6 | – | – | W 1 | - | } correct. |
| 7 | G 2 | – | W 1 | - | |
| 8 | R 2 | R 3 | G 1 | - | |
| 9 | – | G 3 | – | - | g g |
| 10 | R 2 | – | W 1 | - | r r |
| 11 | G 2 | R 3 | W 1 | - | w w |

Distance 2,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | R 2 | R 3 | W 1 | - | } correct. |
| 2 | G 2 | – | – | - | |
| 3 | G 2 | – | W 1 | - | |
| 4 | – | W 3 | – | - | |
| 5 | R 2 | W 3 | W 1 | - | |
| 6 | G 2 | R 3 | G 1 | - | |
| 7 | – | – | G 1 | - | |
| 8 | R 2 | – | W 1 | - | |
| 9 | – | – | G 1 | - | |
| 10 | – | W 3 | – | - | |
| 11 | G 2 | R 3 | R 1 | - | |

Distance 2,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 2 | – | R 1 | - | } correct. |
| 2 | W 2 | W 3 | R 1 | - | |
| 3 | G 2 | – | – | - | |
| 4 | G 2 | R 3 | – | - | |
| 5 | R 2 | G 3 | W 1 | - | |
| 6 | – | G 3 | – | - | |
| 7 | G 2 | – | W 1 | - | |
| 8 | R 2 | – | W 1 | - | |
| 9 | – | W 3 | – | - | |
| 10 | – | – | G 1 | - | |
| 11 | G 2 | – | G 1 | - | |

OBSERVER No. 16.

Distance 3,000 yards (with binoculars).

| Observation. | Lights shown. | | | | Report. |
|---|---|---|---|---|---|
| 1 | R 2 | W 3 | R 1 | - | } correct. |
| 2 | G 2 | – | G 1 | - | |
| 3 | G 2 | – | R 1 | - | |
| 4 | W 2 | – | – | - | w g |
| 5 | – | W 3 | – | - | g w |
| 6 | – | – | W 1 | - | g g |
| 7 | G 2 | – | W 1 | - | correct. |
| 8 | R 2 | R 3 | G 1 | - | r r |
| 9 | – | G 3 | – | - | g g |
| 10 | R 2 | – | W 1 | - | } correct. |
| 11 | G 2 | R 3 | W 1 | - | |

Distance 1,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 2 | R 3 | R 1 | - | } correct. |
| 2 | – | W 3 | – | - | |
| 3 | W 2 | – | G 1 | - | |
| 4 | W 2 | – | R 1 | - | |
| 5 | – | G 3 | – | - | |
| 6 | R 2 | W 3 | G 1 | - | |
| 7 | W 2 | G 3 | W 1 | - | |
| 8 | – | R 3 | – | - | |
| 9 | – | – | W 1 | - | |
| 10 | G 2 | – | – | - | |
| 11 | R 2 | W 3 | R 1 | - | |

NINTH NIGHT—NOVEMBER 22ND.

There was a slight haze, sufficient to render the lights practically invisible at 3,000 yards. They could just be seen at 2,500 yards. The haze remained about the same throughout the observations at all distances. The weather was otherwise fine.

OBSERVER No. 10.

Distance 2,500 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 3 | R 1 | R 2 | - | r r r |
| 2 | – | W 1 | – | - | |
| 3 | W 3 | – | G 2 | - | |
| 4 | W 3 | – | R 2 | - | |
| 5 | – | G 1 | – | - | |
| 6 | R 3 | W 1 | G 2 | - | } correct. |
| 7 | W 3 | G 1 | W 2 | - | |
| 8 | – | R 1 | – | - | |
| 9 | – | – | W 2 | - | |
| 10 | G 3 | – | – | - | |
| 11 | R 3 | W 1 | R 2 | - | w w r |

Distance 2,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 3 | – | R 2 | - | g r |
| 2 | W 3 | W 1 | R 2 | - | g g r |
| 3 | G 3 | – | – | - | } correct. |
| 4 | – | R 1 | – | - | |
| 5 | R 3 | G 1 | W 2 | - | w g r |
| 6 | – | G 1 | – | - | correct. |
| 7 | G 3 | – | W 2 | - | w |
| 8 | R 3 | – | W 2 | - | w w |
| 9 | – | W 1 | – | - | } correct. |
| 10 | – | – | G 2 | - | |
| 11 | G 3 | – | G 2 | - | |

Distance 1,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | R 3 | – | W 2 | - | } correct. |
| 2 | – | – | R 2 | - | |
| 3 | G 3 | – | W 2 | - | |
| 4 | – | – | G 2 | - | |
| 5 | W 3 | – | W 2 | - | |
| 6 | W 3 | – | G 2 | - | |
| 7 | W 3 | R 1 | – | - | |
| 8 | W 3 | G 1 | – | - | |
| 9 | G 3 | – | W 2 | - | |
| 10 | R 3 | – | G 2 | - | |
| 11 | G 3 | – | R 2 | - | |



OBSERVER No. 11.

Distance 2,500 yards.

| Observation. | Lights shown. | | | | Report. |
|---|---|---|---|---|---|
| 1 | W 3 | R 1 | R 2 | - | r r r |
| 2 | – | W 1 | – | - | } correct. |
| 3 | W 3 | – | G 2 | - | |
| 4 | W 3 | – | R 2 | - | |
| 5 | – | G 1 | – | - | |
| 6 | R 3 | W 1 | G 2 | - | |
| 7 | W 3 | G 1 | W 2 | - | r g w |
| 8 | – | R 1 | – | - | } correct. |
| 9 | – | – | W 2 | - | |
| 10 | G 3 | – | – | - | |
| 11 | R 3 | W 1 | R 2 | - | w w r |

Distance 2,500 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 3 | – | G 2 | - | } correct. |
| 2 | W 3 | R 1 | G 2 | - | |
| 3 | R 3 | W 1 | G 2 | - | r r g |
| 4 | G 3 | – | – | - | } correct. |
| 5 | – | W 1 | – | - | |
| 6 | – | R 1 | G 2 | - | |
| 7 | – | W 1 | R 2 | - | |
| 8 | R 3 | W 1 | W 2 | - | w r w |
| 9 | – | – | W 2 | - | } correct. |
| 10 | W 3 | – | G 2 | - | |
| 11 | – | G 1 | W 2 | - | |

Distance 2,500 yards (with binoculars).

| | | | | | |
|---|---|---|---|---|---|
| 1 | R 3 | W 1 | R 2 | - | } correct. |
| 2 | G 3 | – | G 2 | - | |
| 3 | G 3 | – | R 2 | - | |
| 4 | W 3 | – | – | - | |
| 5 | – | W 1 | – | - | |
| 6 | – | – | W 2 | - | |
| 7 | G 3 | – | W 2 | - | |
| 8 | R 3 | R 1 | G 2 | - | |
| 9 | – | G 1 | – | - | |
| 10 | R 3 | – | W 2 | - | |
| 11 | G 3 | R 1 | W 2 | - | |

Distance 2,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 3 | – | R 2 | - | } correct. |
| 2 | W 3 | W 1 | R 2 | - | |
| 3 | G 3 | – | – | - | |
| 4 | – | R 1 | – | - | |
| 5 | R 3 | G 1 | W 2 | - | |
| 6 | – | G 1 | – | - | } correct. |
| 7 | G 3 | – | W 2 | - | |
| 8 | R 3 | – | W 2 | - | |
| 9 | – | W 1 | – | - | |
| 10 | – | – | G 2 | - | |
| 11 | G 3 | – | G 2 | - | |

Distance 2,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | R 3 | R 1 | W 2 | - | } correct. |
| 2 | G 3 | – | – | - | |
| 3 | G 3 | – | W 2 | - | |
| 4 | – | W 1 | – | - | |
| 5 | R 3 | W 1 | W 2 | - | |
| 6 | G 3 | R 1 | G 2 | - | |
| 7 | – | – | G 2 | - | |
| 8 | R 3 | – | W 2 | - | |
| 9 | – | – | G 2 | - | |
| 10 | – | W 1 | – | - | |
| 11 | – | R 1 | R 2 | - | |

Distance 1,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | R 3 | – | W 2 | - | } correct. |
| 2 | – | – | R 2 | - | |
| 3 | G 3 | – | W 2 | - | |
| 4 | – | – | G 2 | - | |
| 5 | W 3 | – | W 2 | - | |
| 6 | W 3 | – | G 2 | - | |
| 7 | W 3 | R 1 | – | - | |
| 8 | W 3 | G 1 | – | - | |
| 9 | G 3 | – | W 2 | - | |
| 10 | R 3 | – | G 2 | - | |
| 11 | G 3 | – | R 2 | - | |

Distance 1,000 yards.

| Observation. | Lights shown. | | | | Report. |
|---|---|---|---|---|---|
| 1 | R 3 | R 1 | W 2 | - | } correct. |
| 2 | G 3 | – | – | - | |
| 3 | G 3 | – | W 2 | - | |
| 4 | – | W 1 | – | - | |
| 5 | R 3 | W 1 | W 2 | - | |
| 6 | G 3 | R 1 | G 2 | - | |
| 7 | – | – | G 2 | - | |
| 8 | R 3 | – | W 2 | - | |
| 9 | – | – | G 2 | - | |
| 10 | – | W 1 | – | - | |
| 11 | G 3 | R 1 | R 2 | - | |

OBSERVER No. 13.

Distance 2,500 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 3 | R 1 | R 2 | - | g r w |
| 2 | – | W 1 | – | - | g |
| 3 | W 3 | – | G 2 | - | g g |
| 4 | W 3 | – | R 2 | - | g r |
| 5 | – | G 1 | – | - | correct |
| 6 | R 3 | W 1 | G 2 | - | g w w |
| 7 | W 3 | G 1 | W 2 | - | w w g |
| 8 | – | R 1 | – | - | correct |
| 9 | – | – | W 2 | - | w g |
| 10 | G 3 | – | – | - | correct |
| 11 | R 3 | W 1 | R 2 | - | g r r |

Distance 2,500 yards (with binoculars).

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 3 | – | G 2 | - | } correct. |
| 2 | W 3 | R 1 | G 2 | - | |
| 3 | R 3 | W 1 | G 2 | - | |
| 4 | G 3 | – | – | - | w |
| 5 | – | W 1 | – | - | } correct. |
| 6 | – | R 1 | G 2 | - | |
| 7 | – | W 1 | R 2 | - | |
| 8 | R 3 | W 1 | W 2 | - | |
| 9 | – | – | W 2 | - | |
| 10 | W 3 | – | G 2 | - | |
| 11 | – | G 1 | W 2 | - | |

Distance 2,500 yards (with binoculars).

| | | | | | |
|---|---|---|---|---|---|
| 1 | R 3 | W 1 | R 2 | - | } correct. |
| 2 | G 3 | – | G 2 | - | |
| 3 | – | – | R 2 | - | |
| 4 | W 3 | – | – | - | |
| 5 | – | W 1 | – | - | |
| 6 | – | – | W 2 | - | } correct. |
| 7 | G 3 | – | W 2 | - | |
| 8 | R 3 | R 1 | G 2 | - | |
| 9 | – | G 1 | – | - | |
| 10 | R 3 | – | W 2 | - | |
| 11 | G 3 | R 1 | W 2 | - | |

Distance 2,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 3 | – | R 2 | - | } correct. |
| 2 | W 3 | W 1 | R 2 | - | |
| 3 | – | – | – | - | w |
| 4 | – | R 1 | – | - | } correct. |
| 5 | R 3 | G 1 | W 2 | - | |
| 6 | – | G 1 | – | - | |
| 7 | G 3 | – | W 2 | - | |
| 8 | R 3 | – | W 2 | - | |
| 9 | – | – | G 2 | - | |
| 10 | – | W 1 | – | - | |
| 11 | – | R 1 | R 2 | - | |

Distance 2,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | R 3 | R 1 | W 2 | - | } correct. |
| 2 | G 3 | – | – | - | |
| 3 | – | – | W 2 | - | |
| 4 | – | W 1 | – | - | |
| 5 | R 3 | W 1 | W 2 | - | |
| 6 | – | R 1 | G 2 | - | |
| 7 | – | – | G 2 | - | |
| 8 | R 3 | – | W 2 | - | |
| 9 | – | – | G 2 | - | |
| 10 | – | W 1 | – | - | |
| 11 | – | R 1 | R 2 | - | |

Distance 1,000 yards.

| Observation. | Lights shown. | | | | Report. |
|---|---|---|---|---|---|
| 1 | R 3 | – | W 2 | - - | correct. |
| 2 | – | – | R 2 | - - | |
| 3 | G 3 | – | W 2 | - - | |
| 4 | – | – | G 2 | - - | |
| 5 | W 3 | – | W 2 | - - | |
| 6 | W 3 | – | G 2 | - - | |
| 7 | W 3 | R 1 | – | - - | |
| 8 | W 3 | G 1 | – | - - | |
| 9 | G 3 | – | W 2 | - - | |
| 10 | R 3 | – | G 2 | - - | |
| 11 | G 3 | – | R 2 | - - | |

OBSERVER No. 14.

Distance 2,500 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 3 | – | G 2 | - - | g g |
| 2 | W 3 | R 1 | G 2 | - - | g w |
| 3 | R 3 | W 1 | G 2 | - - | correct. |
| 4 | G 3 | – | – | - - | |
| 5 | – | W 1 | – | - - | |
| 6 | – | R 1 | G 2 | - - | |
| 7 | – | W 1 | R 2 | - - | |
| 8 | R 3 | W 1 | W 2 | - - | w r w |
| 9 | – | – | W 2 | - - | correct. |
| 10 | W 3 | – | G 2 | - - | r g |
| 11 | – | G 1 | W 2 | - - | w g |

Distance 2,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | R 3 | R 1 | W 2 | - - | correct. |
| 2 | G 3 | – | – | - - | |
| 3 | – | – | W 2 | - - | |
| 4 | – | W 1 | – | - - | |
| 5 | R 3 | W 1 | W 2 | - - | r g g |
| 6 | – | R 1 | G 2 | - - | correct. |
| 7 | – | – | G 2 | - - | |
| 8 | R 3 | – | W 2 | - - | |
| 9 | – | – | G 2 | - - | |
| 10 | – | W 1 | – | - - | |
| 11 | – | R 1 | R 2 | - - | |

Distance 1,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | R 3 | R 1 | W 2 | - - | correct. |
| 2 | G 3 | – | – | - - | |
| 3 | G 3 | – | W 2 | - - | |
| 4 | – | W 1 | – | - - | |
| 5 | R 3 | W 1 | W 2 | - - | |
| 6 | G 3 | R 1 | G 2 | - - | |
| 7 | – | – | G 2 | - - | |
| 8 | R 3 | – | W 2 | - - | |
| 9 | – | – | G 2 | - - | |
| 10 | – | W 1 | – | - - | |
| 11 | G 3 | R 1 | R 2 | - - | |

OBSERVER No. 16.

Distance 2,500 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | R 3 | W 1 | R 2 | - - | g r |
| 2 | G 3 | – | G 2 | - - | g w |
| 3 | – | – | R 2 | - - | correct. |
| 4 | W 3 | – | – | - - | |
| 5 | – | W 1 | – | - - | g |
| 6 | – | – | W 2 | - - | g w |
| 7 | – | – | W 2 | - - | g g |
| 8 | R 3 | R 1 | G 2 | - - | g r |
| 9 | – | G 1 | – | - - | g g |
| 10 | R 3 | – | W 2 | - - | w |
| 11 | – | R 1 | W 2 | - - | w r |

Distance 1,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | R 3 | R 1 | W 2 | - - | correct. |
| 2 | G 3 | – | – | - - | |
| 3 | G 3 | – | W 2 | - - | |
| 4 | – | W 1 | – | - - | |
| 5 | R 3 | W 1 | W 2 | - - | |
| 6 | G 3 | R 1 | G 2 | - - | |
| 7 | – | – | G 2 | - - | |
| 8 | R 3 | – | W 2 | - - | |
| 9 | – | – | G 2 | - - | |
| 10 | – | W 1 | – | - - | |
| 11 | G 3 | R 1 | R 2 | - - | |

TENTH NIGHT—NOVEMBER 23RD.

There was a strong wind blowing direct from the observer to the lamps, with the result that the two oil-lamps could not be kept fully turned up without smoking. Consequently, the lights on those lamps were much dimmer than on any of the preceding nights. The velocity of the wind was 36 miles per hour. It was fine and clear throughout.

OBSERVER No. 11.

Distance 3,000 yards.

| Observation. | Lights shown. | | | | Report. |
|---|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | - - | correct. |
| 2 | G 1 | – | W 3 | - - | |
| 3 | G 1 | – | G 3 | - - | |
| 4 | R 1 | G 2 | G 3 | - - | r r g |
| 5 | W 1 | R 2 | G 3 | - - | |
| 6 | G 1 | W 2 | R 3 | - - | correct. |
| 7 | G 1 | – | R 3 | - - | |
| 8 | R 1 | W 2 | G 3 | - - | |
| 9 | W 1 | – | R 3 | - - | |
| 10 | R 1 | – | R 3 | - - | |
| 11 | G 1 | R 2 | W 3 | - - | g r r |

Distance 3,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | - - | correct. |
| 2 | G 1 | – | R 3 | - - | |
| 3 | W 1 | R 2 | G 3 | - - | w r |
| 4 | R 1 | – | R 3 | - - | correct. |
| 5 | G 1 | R 2 | W 3 | - - | |
| 6 | G 1 | – | W 3 | - - | |
| 7 | G 1 | W 2 | R 3 | - - | |
| 8 | W 1 | – | R 3 | - - | |
| 9 | R 1 | G 2 | G 3 | - - | |
| 10 | G 1 | – | G 3 | - - | |
| 11 | R 1 | W 2 | G 3 | - - | |

Distance 3,000 yards (with binoculars).

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | - - | correct. |
| 2 | W 1 | – | R 3 | - - | |
| 3 | G 1 | – | R 3 | - - | |
| 4 | R 1 | – | R 3 | - - | |
| 5 | G 1 | W 2 | R 3 | - - | |
| 6 | W 1 | R 2 | G 3 | - - | |
| 7 | R 1 | W 2 | G 3 | - - | |
| 8 | G 1 | – | G 3 | - - | |
| 9 | R 1 | G 2 | G 3 | - - | |
| 10 | G 1 | R 2 | W 3 | - - | |
| 11 | G 1 | – | W 3 | - - | |

Distance 3,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | - - | correct. |
| 2 | W 1 | R 2 | G 3 | - - | |
| 3 | W 1 | – | R 3 | - - | correct. |
| 4 | R 1 | – | R 3 | - - | |
| 5 | R 1 | W 2 | G 3 | - - | |
| 6 | R 1 | G 2 | G 3 | - - | correct. |
| 7 | G 1 | R 2 | W 3 | - - | |
| 8 | G 1 | – | R 3 | - - | |
| 9 | G 1 | – | G 3 | - - | correct. |
| 10 | G 1 | – | W 3 | - - | |
| 11 | G 1 | W 2 | R 3 | - - | g w w |

Distance 2,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | W 2 | W 3 | - - | correct. |
| 2 | G 1 | – | G 3 | - - | |
| 3 | G 1 | – | G 3 | - - | |
| 4 | G 1 | R 2 | W 3 | - - | |
| 5 | G 1 | – | W 3 | - - | |
| 6 | G 1 | W 2 | R 3 | - - | correct. |
| 7 | R 1 | – | R 3 | - - | |
| 8 | G 1 | – | G 3 | - - | |
| 9 | R 1 | G 2 | G 3 | - - | |
| 10 | G 1 | – | G 3 | - - | |
| 11 | G 1 | R 2 | G 3 | - - | |



Distance 2,000 yards.

| Observation. | Lights shown. | | | | Report. |
|---|---|---|---|---|---|
| 1 | W 2 | W 1 | W 3 | - - | correct. |
| 2 | W 2 | G 1 | R 3 | - - | |
| 3 | G 2 | G 1 | G 3 | - - | |
| 4 | R 2 | – | W 3 | - - | |
| 5 | G 2 | G 1 | W 3 | - - | |
| 6 | G 2 | – | G 3 | - - | |
| 7 | R 2 | – | W 3 | - - | |
| 8 | R 2 | G 1 | W 3 | - - | |
| 9 | G 2 | – | W 3 | - - | |
| 10 | W 2 | – | G 3 | - - | |
| 11 | R 2 | W 1 | G 3 | - - | |

Distance 2,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 2 | W 1 | W 3 | - - | correct. |
| 2 | G 2 | G 1 | W 3 | - - | |
| 3 | R 2 | – | R 3 | - - | |
| 4 | W 2 | – | G 3 | - - | |
| 5 | W 2 | G 1 | G 3 | - - | |
| 6 | G 2 | R 1 | W 3 | - - | |
| 7 | R 2 | W 1 | G 3 | - - | |
| 8 | G 2 | – | W 3 | - - | |
| 9 | W 2 | W 1 | G 3 | - - | |
| 10 | R 2 | – | W 3 | - - | |
| 11 | G 2 | – | R 3 | - - | |

Distance 2,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 2 | W 1 | W 3 | - - | correct. |
| 2 | G 2 | R 1 | G 3 | - - | |
| 3 | W 2 | – | R 3 | - - | |
| 4 | R 2 | – | R 3 | - - | |
| 5 | R 2 | W 1 | G 3 | - - | |
| 6 | R 2 | G 1 | G 3 | - - | |
| 7 | G 2 | R 1 | W 3 | - - | |
| 8 | G 2 | – | R 3 | - - | |
| 9 | G 2 | – | G 3 | - - | |
| 10 | G 2 | – | W 3 | - - | |
| 11 | G 2 | W 1 | R 3 | - - | g r r |

ELEVENTH NIGHT—NOVEMBER 24TH.

It was fine and clear throughout, but the wind affected the middle lamp, which was much dimmer than the other oil-lamp.

OBSERVER No. 10.

Distance 3,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | - - | correct. |
| 2 | G 1 | – | R 2 | - - | |
| 3 | W 1 | R 3 | G 2 | - - | w w g |
| 4 | R 1 | – | R 2 | - - | w w |
| 5 | G 1 | R 3 | W 2 | - - | g g w |
| 6 | G 1 | – | W 2 | - - | correct. |
| 7 | G 1 | W 3 | R 2 | - - | g g r |
| 8 | W 1 | – | R 2 | - - | correct. |
| 9 | R 1 | – | G 2 | - - | |
| 10 | G 1 | – | G 2 | - - | |
| 11 | R 1 | W 3 | G 2 | - - | r g g |

Distance 2,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | - - | correct. |
| 2 | G 1 | – | W 2 | - - | |
| 3 | G 1 | – | G 2 | - - | |
| 4 | R 1 | G 3 | G 2 | - - | |
| 5 | W 1 | R 3 | G 2 | - - | |
| 6 | G 1 | W 3 | R 2 | - - | g r r |
| 7 | G 1 | – | R 2 | - - | correct. |
| 8 | R 1 | W 3 | G 2 | - - | |
| 9 | W 1 | – | R 2 | - - | |
| 10 | R 1 | – | R 2 | - - | |
| 11 | G 1 | R 3 | W 2 | - - | |

OBSERVER No. 11.

Distance 3,000 yards.

| Observation. | Lights shown. | | | | Report. |
|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | - - | correct. |
| 2 | G 1 | – | R 2 | - - | |
| 3 | W 1 | R 3 | G 2 | - - | |
| 4 | R 1 | – | R 2 | - - | |
| 5 | G 1 | R 3 | W 2 | - - | |
| 6 | G 1 | – | W 2 | - - | |
| 7 | G 1 | W 3 | R 2 | - - | g r r |
| 8 | W 1 | – | R 2 | - - | correct. |
| 9 | R 1 | G 3 | G 2 | - - | |
| 10 | G 1 | – | G 2 | - - | |
| 11 | R 1 | W 3 | G 2 | - - | |

Distance 3,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | – | W 2 | - - | correct. |
| 2 | W 1 | – | G 2 | - - | |
| 3 | W 1 | – | R 2 | - - | |
| 4 | R 1 | – | R 2 | - - | |
| 5 | R 1 | – | G 2 | - - | |
| 6 | R 1 | – | G 2 | - - | |
| 7 | G 1 | – | W 2 | - - | |
| 8 | G 1 | – | R 2 | - - | |
| 9 | G 1 | – | G 2 | - - | |
| 10 | G 1 | – | W 2 | - - | |
| 11 | G 1 | – | R 2 | - - | |

Distance 2,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | - - | correct. |
| 2 | G 1 | – | W 2 | - - | |
| 3 | G 1 | – | G 2 | - - | |
| 4 | R 1 | G 3 | G 2 | - - | |
| 5 | W 1 | R 3 | G 2 | - - | |
| 6 | G 1 | W 3 | R 2 | - - | g r r |
| 7 | G 1 | – | R 2 | - - | correct. |
| 8 | R 1 | W 3 | G 2 | - - | |
| 9 | W 1 | – | R 2 | - - | |
| 10 | R 1 | – | R 2 | - - | |
| 11 | G 1 | R 3 | W 2 | - - | |

Distance 2,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | - - | correct. |
| 2 | R 1 | – | R 2 | - - | |
| 3 | R 1 | W 3 | G 2 | - - | |
| 4 | R 1 | G 3 | G 2 | - - | |
| 5 | G 1 | – | R 2 | - - | |
| 6 | G 1 | W 3 | R 2 | - - | g r r |
| 7 | G 1 | – | W 2 | - - | |
| 8 | G 1 | R 3 | W 2 | - - | |
| 9 | G 1 | – | G 2 | - - | correct. |
| 10 | W 1 | R 3 | G 2 | - - | |
| 11 | W 1 | – | R 2 | - - | |

Distance 2,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | - - | correct. |
| 2 | G 1 | – | R 2 | - - | |
| 3 | W 1 | R 3 | G 2 | - - | |
| 4 | R 1 | – | G 2 | - - | |
| 5 | W 1 | R 3 | G 2 | - - | |
| 6 | G 1 | – | R 2 | - - | |
| 7 | G 1 | W 3 | R 2 | - - | g r r |
| 8 | G 1 | – | W 2 | - - | |
| 9 | G 1 | R 3 | W 2 | - - | |
| 10 | G 1 | – | G 2 | - - | correct. |
| 11 | G 1 | W 3 | R 2 | - - | |

OBSERVER No. 13.

Distance 2,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | - - | correct. |
| 2 | R 1 | – | R 2 | - - | |
| 3 | R 1 | W 3 | G 3 | - - | r r g |
| 4 | R 1 | G 3 | G 2 | - - | r g |
| 5 | G 1 | – | R 2 | - - | r |
| 6 | G 1 | W 3 | R 2 | - - | g r |
| 7 | G 1 | – | W 2 | - - | correct. |
| 8 | G 1 | R 3 | W 2 | - - | g w w |
| 9 | G 1 | – | G 2 | - - | correct. |
| 10 | W 1 | R 3 | G 2 | - - | w w g |
| 11 | W 1 | – | R 2 | - - | correct. |

Distance 2,000 yards (with binoculars).

| Observation. | Lights shown. | | | | Report. |
|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | - - | w w |
| 2 | G 1 | R 3 | W 2 | - - | |
| 3 | R 1 | W 3 | G 2 | - - | |
| 4 | R 1 | – | G 2 | - - | |
| 5 | W 1 | R 3 | G 2 | - - | correct. |
| 6 | G 1 | – | R 2 | - - | |
| 7 | G 1 | – | W 2 | - - | |
| 8 | R 1 | – | R 2 | - - | |
| 9 | W 1 | – | R 2 | - - | |
| 10 | G 1 | – | G 2 | - - | |
| 11 | G 1 | – | R 2 | - - | |

Distance 3,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | - - | correct. |
| 2 | G 1 | – | R 2 | - - | |
| 3 | W 1 | R 3 | G 2 | - - | w w g |
| 4 | R 1 | – | R 2 | - - | r r r |
| 5 | G 1 | R 3 | W 2 | - - | w w |
| 6 | G 1 | – | W 2 | - - | correct. |
| 7 | G 1 | W 3 | R 2 | - - | r w |
| 8 | W 1 | – | R 2 | - - | w w r |
| 9 | R 1 | G 3 | G 2 | - - | correct. |
| 10 | G 1 | – | G 2 | - - | |
| 11 | R 1 | W 3 | G 2 | - - | r g |

Distance 3,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | – | W 2 | - - | |
| 2 | W 1 | – | G 2 | - - | |
| 3 | W 1 | – | R 2 | - - | correct. |
| 4 | R 1 | – | R 2 | - - | |
| 5 | R 1 | – | G 2 | - - | |
| 6 | R 1 | – | G 2 | - - | |
| 7 | G 1 | – | W 2 | - - | w |
| 8 | G 1 | – | R 2 | - - | r |
| 9 | G 1 | – | G 2 | - - | |
| 10 | G 1 | – | W 2 | - - | correct. |
| 11 | G 1 | – | R 2 | - - | |

Distance 3,000 yards (with binoculars).

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | – | W 2 | - - | |
| 2 | W 1 | – | R 2 | - - | |
| 3 | G 1 | – | R 2 | - - | |
| 4 | R 1 | – | R 2 | - - | |
| 5 | G 1 | – | R 2 | - - | correct. |
| 6 | W 1 | – | G 2 | - - | |
| 7 | R 1 | – | G 2 | - - | |
| 8 | G 1 | – | G 2 | - - | |
| 9 | R 1 | – | G 2 | - - | |
| 10 | G 1 | – | W 2 | - - | |

Distance 2,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | - - | |
| 2 | G 1 | – | W 2 | - - | |
| 3 | G 1 | – | G 2 | - - | correct. |
| 4 | R 1 | G 3 | G 2 | - - | |
| 5 | W 1 | R 3 | G 2 | - - | w w g |
| 6 | G 1 | W 3 | R 2 | - - | g r |
| 7 | G 1 | – | R 2 | - - | g r g |
| 8 | R 1 | W 3 | G 2 | - - | r g g |
| 9 | W 1 | – | R 2 | - - | |
| 10 | R 1 | – | R 2 | - - | correct. |
| 11 | G 1 | R 3 | W 2 | - - | g w w |

Observer No. 14.

Distance 3,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | – | W 2 | - - | |
| 2 | W 1 | – | R 2 | - - | |
| 3 | G 1 | – | R 2 | - - | |
| 4 | R 1 | – | R 2 | - - | |
| 5 | G 1 | – | R 2 | - - | |
| 6 | W 1 | – | G 2 | - - | correct. |
| 7 | R 1 | – | G 2 | - - | |
| 8 | G 1 | – | G 2 | - - | |
| 9 | R 1 | – | G 2 | - - | |
| 10 | G 1 | – | W 2 | - - | |
| 11 | G 1 | – | W 2 | - - | |

Distance 2,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | W 3 | W 2 | - - | correct. |
| 2 | G 1 | R 3 | W 2 | - - | g g w |
| 3 | R 1 | W 3 | G 2 | - - | r g g |
| 4 | R 1 | – | G 2 | - - | correct. |
| 5 | W 1 | R 3 | G 2 | - - | r w g |
| 6 | G 1 | – | R 2 | - - | |
| 7 | G 1 | – | W 2 | - - | correct. |
| 8 | R 1 | – | R 2 | - - | |
| 9 | W 1 | – | R 2 | - - | |
| 10 | G 1 | – | G 2 | - - | g g g |
| 11 | G 1 | – | R 2 | - - | correct. |

TWELFTH NIGHT—NOVEMBER 25TH.

It was fine and clear throughout.

Observer No. 10.

Distance 2,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | – | W 2 | - - | |
| 2 | G 1 | – | W 2 | - - | |
| 3 | G 1 | – | G 2 | - - | |
| 4 | R 1 | – | G 2 | - - | correct. |
| 5 | W 1 | – | G 2 | - - | |
| 6 | G 1 | – | R 2 | - - | |
| 7 | G 1 | – | R 2 | - - | |
| 8 | R 1 | – | G 2 | - - | w g |
| 9 | W 1 | – | R 2 | - - | correct. |
| 10 | R 1 | – | R 2 | - - | g r |
| 11 | G 1 | – | W 2 | - - | correct. |

Observer No. 11.

Distance 3,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | – | W 2 | - - | |
| 2 | R 1 | – | G 2 | - - | |
| 3 | W 1 | – | G 2 | - - | |
| 4 | G 1 | – | W 2 | - - | |
| 5 | W 1 | – | R 2 | - - | |
| 6 | G 1 | – | R 2 | - - | correct. |
| 7 | G 1 | – | G 2 | - - | |
| 8 | R 1 | – | R 2 | - - | |
| 9 | G 1 | – | R 2 | - - | |
| 10 | R 1 | – | G 2 | - - | |
| 11 | G 1 | – | W 2 | - - | |



Distance 2,000 yards.

| Observation. | Lights shown. | | | | Report. |
|---|---|---|---|---|---|
| 1 | W 1 | – | W 2 | - - | |
| 2 | G 1 | – | W 2 | - - | |
| 3 | G 1 | – | G 2 | - - | |
| 4 | R 1 | – | G 2 | - - | |
| 5 | W 1 | – | G 2 | - - | |
| 6 | G 1 | – | R 2 | - - | correct. |
| 7 | G 1 | – | R 2 | - - | |
| 8 | R 1 | – | G 2 | - - | |
| 9 | W 1 | – | R 2 | - - | |
| 10 | R 1 | – | R 2 | - - | |
| 11 | G 1 | – | W 2 | - - | |

Observer No. 13.

Distance 3,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | – | W 2 | - - | |
| 2 | G 1 | – | G 2 | - - | |
| 3 | G 1 | – | R 2 | - - | |
| 4 | G 1 | – | W 2 | - - | |
| 5 | G 1 | – | W 2 | - - | |
| 6 | G 1 | – | R 2 | - - | correct. |
| 7 | R 1 | – | R 2 | - - | |
| 8 | R 1 | – | G 2 | - - | |
| 9 | R 1 | – | G 2 | - - | |
| 10 | W 1 | – | R 2 | - - | |
| 11 | W 1 | – | G 2 | - - | |

Distance 2,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | – | W 2 | - - | |
| 2 | G 1 | – | W 2 | - - | |
| 3 | G 1 | – | G 2 | - - | |
| 4 | R 1 | – | G 2 | - - | |
| 5 | W 1 | – | G 2 | - - | |
| 6 | G 1 | – | R 2 | - - | correct. |
| 7 | G 1 | – | R 2 | - - | |
| 8 | R 1 | – | G 2 | - - | |
| 9 | W 1 | – | R 2 | - - | |
| 10 | R 1 | – | R 2 | - - | |
| 11 | G 1 | – | W 2 | - - | |

Observer No. 14.

Distance 3,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | – | W 2 | - - | |
| 2 | W 1 | – | R 2 | - - | |
| 3 | G 1 | – | G 2 | - - | |
| 4 | R 1 | – | W 2 | - - | |
| 5 | G 1 | – | W 2 | - - | |
| 6 | G 1 | – | G 2 | - - | correct. |
| 7 | R 1 | – | W 2 | - - | |
| 8 | R 1 | – | W 2 | - - | |
| 9 | G 1 | – | W 2 | - - | |
| 10 | W 1 | – | G 2 | - - | |
| 11 | R 1 | – | G 2 | - - | |

Observer No. 16.

Distance 3,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | – | W 2 | - - | |
| 2 | G 1 | – | W 2 | - - | |
| 3 | G 1 | – | R 2 | - - | |
| 4 | R 1 | – | R 2 | - - | |
| 5 | R 1 | – | G 2 | - - | |
| 6 | R 1 | – | G 2 | - - | correct. |
| 7 | G 1 | – | W 2 | - - | |
| 8 | G 1 | – | R 2 | - - | |
| 9 | G 1 | – | G 2 | - - | |
| 10 | G 1 | – | W 2 | - - | |
| 11 | G 1 | – | R 2 | - - | |

Distance 3,000 yards (with binoculars).

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | – | W 2 | - - | |
| 2 | W 1 | – | R 2 | - - | |
| 3 | G 1 | – | R 2 | - - | |
| 4 | R 1 | – | R 2 | - - | |
| 5 | W 1 | – | R 2 | - - | |
| 6 | G 1 | – | R 2 | - - | correct. |
| 7 | G 1 | – | R 2 | - - | |
| 8 | R 1 | – | G 2 | - - | |
| 9 | G 1 | – | G 2 | - - | |
| 10 | R 1 | – | G 2 | - - | |
| 11 | G 1 | – | W 2 | - - | |

Distance 2,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | – | W 2 | - - | |
| 2 | G 1 | – | W 2 | - - | |
| 3 | G 1 | – | G 2 | - - | |
| 4 | R 1 | – | G 2 | - - | |
| 5 | W 1 | – | G 2 | - - | |
| 6 | G 1 | – | R 2 | - - | correct. |
| 7 | G 1 | – | R 2 | - - | |
| 8 | R 1 | – | G 2 | - - | |
| 9 | W 1 | – | R 2 | - - | |
| 10 | R 1 | – | R 2 | - - | |
| 11 | G 1 | – | W 2 | - - | |

Observer No. 16.

Distance 3,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | – | W 2 | - - | |
| 2 | G 1 | – | W 2 | - - | |
| 3 | R 1 | – | R 2 | - - | |
| 4 | W 1 | – | G 2 | - - | |
| 5 | W 1 | – | G 2 | - - | |
| 6 | G 1 | – | W 2 | - - | correct. |
| 7 | R 1 | – | G 2 | - - | |
| 8 | G 1 | – | W 2 | - - | |
| 9 | W 1 | – | G 2 | - - | |
| 10 | R 1 | – | W 2 | - - | |
| 11 | G 1 | – | R 2 | - - | |

Observer No. 17.

Distance 3,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | – | W 2 | - - | |
| 2 | R 1 | – | G 2 | - - | |
| 3 | W 1 | – | G 2 | - - | correct. |
| 4 | G 1 | – | W 2 | - - | |
| 5 | W 1 | – | R 2 | - - | g r |
| 6 | G 1 | – | R 2 | - - | |
| 7 | G 1 | – | G 2 | - - | |
| 8 | R 1 | – | R 2 | - - | |
| 9 | G 1 | – | R 2 | - - | correct. |
| 10 | R 1 | – | G 2 | - - | |
| 11 | G 1 | – | W 2 | - - | |

Distance 3,000 yards (with binoculars).

| Observation. | Lights shown. | | | | Report. |
|---|---|---|---|---|---|
| 1 | W 1 | – | W 2 | - - | |
| 2 | G 1 | – | G 2 | - - | |
| 3 | G 1 | – | R 2 | - - | |
| 4 | G 1 | – | W 2 | - - | |
| 5 | G 1 | – | W 2 | - - | |
| 6 | G 1 | – | R 2 | - - | correct. |
| 7 | R 1 | – | R 2 | - - | |
| 8 | G 1 | – | W 2 | - - | |
| 9 | G 1 | – | G 2 | - - | |
| 10 | W 1 | – | G 2 | - - | |
| 11 | G 1 | – | R 2 | - - | |

Distance 3,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | – | W 2 | - - | correct. |
| 2 | W 1 | – | R 2 | - - | g r |
| 3 | G 1 | – | G 2 | - - | |
| 4 | R 1 | – | W 2 | - - | correct. |
| 5 | G 1 | – | W 2 | - - | |
| 6 | G 1 | – | G 2 | - - | |
| 7 | R 1 | – | W 2 | - - | r g |
| 8 | R 1 | – | W 2 | - - | |
| 9 | G 1 | – | W 2 | - - | correct. |
| 10 | W 1 | – | G 2 | - - | |
| 11 | R 1 | – | G 2 | - - | |

Distance 2,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | – | W 2 | - - | |
| 2 | G 1 | – | W 2 | - - | |
| 3 | R 1 | – | G 2 | - - | |
| 4 | R 1 | – | G 2 | - - | correct. |
| 5 | W 1 | – | G 2 | - - | |
| 6 | G 1 | – | R 2 | - - | |
| 7 | G 1 | – | W 2 | - - | |
| 8 | R 1 | – | R 2 | - - | |
| 9 | W 1 | – | R 2 | - - | g r |
| 10 | G 1 | – | G 2 | - - | correct. |
| 11 | G 1 | – | R 2 | - - | |

Distance 2,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | – | W 2 | - - | |
| 2 | R 1 | – | G 2 | - - | |
| 3 | R 1 | – | G 2 | - - | |
| 4 | R 1 | – | W 2 | - - | |
| 5 | G 1 | – | R 2 | - - | correct. |
| 6 | G 1 | – | R 2 | - - | |
| 7 | G 1 | – | W 2 | - - | |
| 8 | W 1 | – | W 2 | - - | |
| 9 | G 1 | – | G 2 | - - | |
| 10 | W 1 | – | G 2 | - - | r g |
| 11 | W 1 | – | R 2 | - - | correct. |

Distance 2,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | – | – | W 1 | W 2 | - - |
| 2 | – | – | G 1 | R 2 | - - |
| 3 | – | – | W 1 | G 2 | - - |
| 4 | – | – | R 1 | R 2 | - - |
| 5 | – | – | G 1 | W 2 | - - |
| 6 | – | – | G 1 | W 2 | - - |
| 7 | – | – | G 1 | R 2 | - - |
| 8 | – | – | W 1 | R 2 | - - |
| 9 | – | – | R 1 | G 2 | - - |
| 10 | – | – | G 1 | G 2 | - - |
| 11 | – | – | R 1 | G 2 | - - |

Observer No. 18.

Distance 3,000 yards.

| | | | | | |
|---|---|---|---|---|---|
| 1 | W 1 | – | W 2 | - - | |
| 2 | R 1 | – | G 2 | - - | |
| 3 | W 1 | – | G 2 | - - | |
| 4 | G 1 | – | W 2 | - - | |
| 5 | W 1 | – | R 2 | - - | |
| 6 | G 1 | – | R 2 | - - | correct. |
| 7 | G 1 | – | G 2 | - - | |
| 8 | R 1 | – | R 2 | - - | |
| 9 | G 1 | – | R 2 | - - | |
| 10 | R 1 | – | G 2 | - - | |
| 11 | G 1 | – | W 2 | - - | |

Distance 3,000 yards (with binoculars).

| Observations. | Lights shown. | | | | | | Report. |
|---|---|---|---|---|---|---|---|
| 1 | - | W 1 | – | W 2 | - | - | correct. |
| 2 | - | G 1 | – | G 2 | - | - | |
| 3 | - | G 1 | – | R 2 | - | - | |
| 4 | - | G 1 | – | W 2 | - | - | |
| 5 | - | G 1 | – | W 2 | - | - | |
| 6 | - | G 1 | – | R 2 | - | - | |
| 7 | - | R 1 | – | R 2 | - | - | |
| 8 | - | R 1 | – | G 2 | - | - | |
| 9 | - | R 1 | – | G 2 | - | - | |
| 10 | - | W 1 | – | R 2 | - | - | |
| 11 | - | W 1 | – | G 2 | - | - | |

Distance 3,000 yards.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | - | W 1 | – | W 2 | - | - | correct. |
| 2 | - | G 1 | – | W 2 | - | - | |
| 3 | - | R 1 | – | R 2 | - | - | |
| 4 | - | W 1 | – | G 2 | - | - | |
| 5 | - | W 1 | – | G 2 | - | - | |
| 6 | - | G 1 | – | W 2 | - | - | |
| 7 | - | R 1 | – | G 2 | - | - | |
| 8 | - | G 1 | – | W 2 | - | - | |
| 9 | - | W 1 | – | G 2 | - | - | |
| 10 | - | R 1 | – | W 2 | - | - | |
| 11 | - | G 1 | – | R 2 | - | - | |

Distance 2,000 yards.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | - | W 1 | – | W 2 | - | - | correct. |
| 2 | - | G 1 | – | W 2 | - | - | |
| 3 | - | R 1 | – | G 2 | - | - | |
| 4 | - | R 1 | – | G 2 | - | - | |
| 5 | - | W 1 | – | G 2 | - | - | |
| 6 | - | G 1 | – | R 2 | - | - | |
| 7 | - | G 1 | – | W 2 | - | - | |
| 8 | - | R 1 | – | R 2 | - | - | |
| 9 | - | W 1 | – | R 2 | - | - | |
| 10 | - | G 1 | – | G 2 | - | - | |
| 11 | - | G 1 | – | R 2 | - | - | |

Distance 2,000 yards.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | - | W 1 | – | W 2 | - | - | correct. |
| 2 | - | R 1 | – | R 2 | - | - | |
| 3 | - | R 1 | – | G 2 | - | - | |
| 4 | - | R 1 | – | G 2 | - | - | |
| 5 | - | G 1 | – | R 2 | - | - | |
| 6 | - | G 1 | – | R 2 | - | - | |
| 7 | - | G 1 | – | W 2 | - | - | |
| 8 | - | G 1 | – | W 2 | - | - | |
| 9 | - | G 1 | – | G 2 | - | - | |
| 10 | - | W 1 | – | G 2 | - | - | |
| 11 | - | W 1 | – | R 2 | - | - | |

Distance 2,000 yards.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | - | – | W 1 | W 2 | - | - | correct. |
| 2 | - | – | G 1 | R 2 | - | - | |
| 3 | - | – | W 1 | G 2 | - | - | |
| 4 | - | – | R 1 | R 2 | - | - | |
| 5 | - | – | G 1 | W 2 | - | - | |
| 6 | - | – | G 1 | W 2 | - | - | |
| 7 | - | – | G 1 | R 2 | - | - | |
| 8 | - | – | W 1 | R 2 | - | - | |
| 9 | - | – | R 1 | G 2 | - | - | |
| 10 | - | – | G 1 | G 2 | - | - | |
| 11 | - | – | R 1 | G 2 | - | - | |

OBSERVER No. 19.

Distance 3,000 yards.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | - | W 1 | – | W 2 | - | - | correct. |
| 2 | - | R 1 | – | G 2 | - | - | |
| 3 | - | W 1 | – | G 2 | - | - | |
| 4 | - | G 1 | – | W 2 | - | - | |
| 5 | - | W 1 | – | R 2 | - | - | |
| 6 | - | G 1 | – | R 2 | - | - | |
| 7 | - | G 1 | – | G 2 | - | - | |
| 8 | - | R 1 | – | R 2 | - | - | |
| 9 | - | G 1 | – | R 2 | - | - | |
| 10 | - | R 1 | – | G 2 | - | - | |
| 11 | - | G 1 | – | W 2 | - | - | |

Distance 3,000 yards (with binoculars).

| Observation. | Lights shown. | | | | | | Report. |
|---|---|---|---|---|---|---|---|
| 1 | - | W 1 | – | W 2 | - | - | correct. |
| 2 | - | W 1 | – | R 2 | - | - | |
| 3 | - | G 1 | – | G 2 | - | - | |
| 4 | - | R 1 | – | W 2 | - | - | |
| 5 | - | G 1 | – | W 2 | - | - | |
| 6 | - | G 1 | – | G 2 | - | - | |
| 7 | - | R 1 | – | G 2 | - | - | |
| 8 | - | R 1 | – | W 2 | - | - | |
| 9 | - | W 1 | – | W 2 | - | - | |
| 10 | - | W 1 | – | G 2 | - | - | |
| 11 | - | R 1 | – | G 2 | - | - | |

Distance 3,000 yards.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | - | W 1 | – | W 2 | - | - | correct. |
| 2 | - | G 1 | – | W 2 | - | - | |
| 3 | - | R 1 | – | R 2 | - | - | |
| 4 | - | W 1 | – | G 2 | - | - | |
| 5 | - | W 1 | – | G 2 | - | - | |
| 6 | - | G 1 | – | W 2 | - | - | |
| 7 | - | R 1 | – | G 2 | - | - | |
| 8 | - | G 1 | – | W 2 | - | - | |
| 9 | - | W 1 | – | G 2 | - | - | |
| 10 | - | R 1 | – | W 2 | - | - | |
| 11 | - | G 1 | – | R 2 | - | - | |

Distance 2,000 yards.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | - | W 1 | – | W 2 | - | - | correct. |
| 2 | - | G 1 | – | W 2 | - | - | |
| 3 | - | G 1 | – | G 2 | - | - | |
| 4 | - | R 1 | – | G 2 | - | - | |
| 5 | - | W 1 | – | G 2 | - | - | |
| 6 | - | G 1 | – | R 2 | - | - | |
| 7 | - | G 1 | – | R 2 | - | - | |
| 8 | - | R 1 | – | G 2 | - | - | |
| 9 | - | W 1 | – | R 2 | - | - | |
| 10 | - | R 1 | – | R 2 | - | - | |
| 11 | - | G 1 | – | W 2 | - | - | |

Distance 2,000 yards.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | - | W 1 | – | W 2 | - | - | correct. |
| 2 | - | G 1 | – | W 2 | - | - | |
| 3 | - | R 1 | – | G 2 | - | - | |
| 4 | - | R 1 | – | G 2 | - | - | |
| 5 | - | W 1 | – | G 2 | - | - | |
| 6 | - | G 1 | – | R 2 | - | - | |
| 7 | - | G 1 | – | W 2 | - | - | |
| 8 | - | R 1 | – | R 2 | - | - | |
| 9 | - | W 1 | – | R 2 | - | - | |
| 10 | - | G 1 | – | G 2 | - | - | |
| 11 | - | G 1 | – | R 2 | - | - | |

Distance 2,000 yards.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | - | W 1 | – | W 2 | - | - | correct. |
| 2 | - | R 1 | – | R 2 | - | - | |
| 3 | - | R 1 | – | G 2 | - | - | |
| 4 | - | R 1 | – | G 2 | - | - | |
| 5 | - | G 1 | – | R 2 | - | - | |
| 6 | - | G 1 | – | R 2 | - | - | |
| 7 | - | G 1 | – | W 2 | - | - | |
| 8 | - | R 1 | – | W 2 | - | - | |
| 9 | - | G 1 | – | G 2 | - | - | |
| 10 | - | W 1 | – | G 2 | - | - | |
| 11 | - | W 1 | – | R 2 | - | - | |

Distance 2,000 yards.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | - | - | W 1 | W 2 | - | - | correct. |
| 2 | - | - | G 1 | R 2 | - | - | |
| 3 | - | - | W 1 | G 2 | - | - | |
| 4 | - | - | R 1 | R 2 | - | - | |
| 5 | - | - | G 1 | W 2 | - | - | |
| 6 | - | - | G 1 | W 2 | - | - | |
| 7 | - | - | G 1 | R 2 | - | - | |
| 8 | - | - | W 1 | R 2 | - | - | |
| 9 | - | - | R 1 | G 2 | - | - | |
| 10 | - | - | G 1 | G 2 | - | - | |
| 11 | - | - | R 1 | G 2 | - | - | |



OBSERVER No. 20.

Distance 3,000 yards.

| Observation. | Lights shown. | | | | | | Report. |
|---|---|---|---|---|---|---|---|
| 1 | - | W 1 | – | W 2 | - | - | correct. |
| 2 | - | G 1 | – | G 2 | - | - | |
| 3 | - | G 1 | – | R 2 | - | - | r g |
| 4 | - | G 1 | – | W 2 | - | - | correct. |
| 5 | - | G 1 | – | W 2 | - | - | |
| 6 | - | R 1 | – | R 2 | - | - | w r |
| 7 | - | R 1 | – | R 2 | - | - | |
| 8 | - | R 1 | – | G 2 | - | - | |
| 9 | - | R 1 | – | G 2 | - | - | correct. |
| 10 | - | W 1 | – | R 2 | - | - | |
| 11 | - | W 1 | – | G 2 | - | - | |

Distance 3,000 yards (with binoculars).

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | - | W 1 | – | W 2 | - | - | correct. |
| 2 | - | W 1 | – | R 2 | - | - | |
| 3 | - | G 1 | – | G 2 | - | - | |
| 4 | - | R 1 | – | W 2 | - | - | |
| 5 | - | G 1 | – | W 2 | - | - | |
| 6 | - | G 1 | – | G 2 | - | - | |
| 7 | - | R 1 | – | W 2 | - | - | |
| 8 | - | R 1 | – | W 2 | - | - | |
| 9 | - | G 1 | – | W 2 | - | - | |
| 10 | - | W 1 | – | G 2 | - | - | |
| 11 | - | R 1 | – | G 2 | - | - | |

Distance 3,000 yards.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | - | R 1 | – | R 2 | - | - | correct. |
| 2 | - | W 1 | – | G 2 | - | - | |
| 3 | - | W 1 | – | G 2 | - | - | |
| 4 | - | G 1 | – | W 2 | - | - | |
| 5 | - | R 1 | – | G 2 | - | - | |
| 6 | - | G 1 | – | W 2 | - | - | |
| 7 | - | W 1 | – | G 2 | - | - | |
| 8 | - | R 1 | – | W 2 | - | - | |
| 9 | - | G 1 | – | R 2 | - | - | |

Distance 2,000 yards.

| Observation. | Lights shown. | | | | | | Report. |
|---|---|---|---|---|---|---|---|
| 1 | - | W 1 | – | W 2 | - | - | correct. |
| 2 | - | G 1 | – | W 2 | - | - | |
| 3 | - | R 1 | – | G 2 | - | - | |
| 4 | - | R 1 | – | G 2 | - | - | |
| 5 | - | W 1 | – | G 2 | - | - | |
| 6 | - | G 1 | – | R 2 | - | - | |
| 7 | - | G 1 | – | W 2 | - | - | |
| 8 | - | R 1 | – | R 2 | - | - | |
| 9 | - | W 1 | – | R 2 | - | - | |
| 10 | - | G 1 | – | G 2 | - | - | |
| 11 | - | G 1 | – | R 2 | - | - | |

Distance 2,000 yards.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | - | W 1 | – | W 2 | - | - | correct. |
| 2 | - | R 1 | – | R 2 | - | - | |
| 3 | - | R 1 | – | G 2 | - | - | |
| 4 | - | R 1 | – | G 2 | - | - | |
| 5 | - | G 1 | – | R 2 | - | - | |
| 6 | - | G 1 | – | R 2 | - | - | |
| 7 | - | G 1 | – | W 2 | - | - | |
| 8 | - | G 1 | – | W 2 | - | - | |
| 9 | - | G 1 | – | G 2 | - | - | |
| 10 | - | W 1 | – | G 2 | - | - | |
| 11 | - | W 1 | – | R 2 | - | - | |

Distance 2,000 yards.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | - | - | W 1 | W 2 | - | - | correct. |
| 2 | - | - | G 1 | R 2 | - | - | |
| 3 | - | - | W 1 | G 2 | - | - | |
| 4 | - | - | R 1 | R 2 | - | - | |
| 5 | - | - | G 1 | W 2 | - | - | |
| 6 | - | - | G 1 | W 2 | - | - | |
| 7 | - | - | G 1 | R 2 | - | - | |
| 8 | - | - | W 1 | R 2 | - | - | |
| 9 | - | - | R 1 | G 2 | - | - | |
| 10 | - | - | G 1 | G 2 | - | - | |
| 11 | - | - | R 1 | G 2 | - | - | |

# APPENDIX L.

## Summary of Results of Experiments conducted at Shoeburyness.

### OBSERVER No. 1.

| Distance. | Number of Lights shown. | Correctly named. R. 1 | R. 2 | R. 3 | G. 1 | G. 2 | G. 3 | W. 1 | W. 2 | W. 3 | Total correctly named. | Failed to see. R. 1 | R. 2 | R. 3 | G. 1 | G. 2 | G. 3 | W. 1 | W. 2 | W. 3 | Total failed to see. | Incorrectly named. R called G. 1 | R called G. 2 | R called G. 3 | R called W. 1 | R called W. 2 | R called W. 3 | G called R. 1 | G called R. 2 | G called R. 3 | G called W. 1 | G called W. 2 | G called W. 3 | W called R. 1 | W called R. 2 | W called R. 3 | W called G. 1 | W called G. 2 | W called G. 3 | Total incorrectly named. | Percentage of Mistakes (i.e. missed and incorrectly named). |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | *Per cent.* |
| 3,000 yards - | 161 | 11 | 15 | 11 | 16 | 18 | 9 | 9 | 15 | 11 | 115 | 2 | – | – | 4 | 1 | 4 | 2 | 1 | – | 14 | 2 | – | – | 2 | 2 | 5 | 1 | – | 1 | – | 1 | 1 | 3 | 1 | 4 | 6 | – | 3 | 32 | *28·6* |
| 2,500 „ - | 26 | 3 | 2 | 5 | 1 | 3 | 2 | 3 | 1 | 1 | 21 | – | – | – | – | – | 1 | – | – | – | 1 | – | – | – | – | – | – | 1 | – | 1 | – | – | – | – | – | 2 | – | – | 4 | *19·2* |
| 2,000 „ - | 248 | 25 | 23 | 17 | 30 | 27 | 29 | 15 | 26 | 22 | 214 | – | – | – | – | – | – | – | – | – | – | – | – | – | 2 | 1 | 3 | 2 | – | 2 | 3 | – | – | 6 | 1 | 9 | 4 | – | 1 | 34 | *13·7* |
| 1,500 „ - | 82 | 10 | 9 | 9 | 7 | 11 | 9 | 10 | 8 | 9 | 82 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | — |
| 1,000 „ - | 270 | 28 | 28 | 31 | 33 | 27 | 33 | 28 | 27 | 28 | 263 | – | – | – | – | – | – | – | – | – | – | – | – | – | 1 | – | 4 | – | – | – | – | – | – | 3 | – | 2 | – | 1 | – | 7 | *2·6* |
| 500 „ - | 17 | 2 | – | 3 | – | – | 5 | 3 | – | 3 | 16 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 1 | – | – | – | – | – | – | – | – | 1 | *5·9* |
| All distances | 804 | 79 | 77 | 76 | 87 | 86 | 87 | 68 | 77 | 74 | 711 | 2 | – | – | 4 | 1 | 5 | 2 | 1 | – | 15 | 2 | – | – | 5 | 3 | 8 | 4 | – | 4 | 4 | 1 | 1 | 12 | 2 | 15 | 12 | 1 | 4 | 78 | *11·6* |
| *With Binoculars.* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3,000 yards - | 28 | 3 | 2 | 4 | 5 | 1 | 4 | 3 | 3 | 3 | 28 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | — |
| 2,000 „ - | 56 | 5 | 5 | 8 | 6 | 6 | 8 | 6 | 6 | 6 | 56 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | — |
| All distances with Binoculars | 84 | 8 | 7 | 12 | 11 | 7 | 12 | 9 | 9 | 9 | 84 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | — |

### OBSERVER No. 2.

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | *Per cent.* |
| 3,000 yards - | 161 | 10 | 10 | 12 | 16 | 17 | 10 | 4 | 15 | 3 | 97 | – | – | – | – | – | – | – | – | – | – | 6 | 1 | 1 | 1 | 6 | 3 | 4 | 2 | 4 | 1 | 1 | 1 | 9 | 1 | 7 | 7 | 1 | 8 | 64 | *39·8* |
| 2,000 „ - | 248 | 18 | 20 | 13 | 22 | 26 | 17 | 11 | 26 | 17 | 170 | – | – | – | – | – | – | – | – | – | – | 9 | 2 | 2 | – | 2 | 5 | 12 | 1 | 13 | 1 | – | 1 | 9 | 1 | 10 | 5 | – | 5 | 78 | *31·4* |
| 1,500 „ - | 56 | 5 | 8 | 4 | 6 | 8 | 6 | 1 | 6 | 3 | 47 | – | – | – | – | – | – | – | – | – | – | – | – | 1 | – | – | – | – | – | – | – | – | – | 2 | – | 2 | 3 | – | 1 | 9 | *16·0* |
| 1,000 „ - | 242 | 26 | 26 | 26 | 26 | 24 | 21 | 14 | 17 | 21 | 201 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 1 | – | – | 4 | 2 | 2 | 4 | 9 | 6 | 4 | 5 | 2 | 2 | 41 | *17·0* |
| 500 „ - | 28 | 1 | 2 | 2 | – | 1 | 5 | 2 | – | 2 | 15 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 3 | – | 2 | – | – | 1 | 3 | 1 | – | 2 | 1 | 13 | *46·4* |
| All distances | 735 | 60 | 66 | 57 | 70 | 76 | 59 | 32 | 64 | 46 | 530 | – | – | – | – | – | – | – | – | – | – | 15 | 3 | 4 | 1 | 8 | 9 | 16 | 6 | 21 | 6 | 3 | 6 | 30 | 11 | 24 | 20 | 5 | 17 | 205 | *27·9* |
| *With Binoculars.* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3,000 yards - (telescope). | 26 | 2 | 3 | 3 | 3 | 2 | 1 | – | 3 | – | 17 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 1 | – | 1 | 1 | 2 | – | – | – | 1 | 3 | – | – | 9 | *34·6* |
| 2,000 yards - | 28 | 2 | 3 | 4 | – | 5 | 4 | – | 2 | 2 | 22 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 1 | – | – | – | – | – | 3 | 1 | 1 | – | – | – | 6 | *21·4* |
| All distances with Binoculars | 54 | 4 | 6 | 7 | 3 | 7 | 5 | – | 5 | 2 | 39 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 2 | – | 1 | 1 | 2 | – | 3 | 1 | 2 | 3 | – | – | 15 | *27·8* |

### OBSERVER No. 3.

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | *Per cent.* |
| 3,000 yards - | 194 | 16 | 18 | 17 | 28 | 19 | 21 | 2 | 20 | 10 | 151 | – | – | – | – | – | 1 | – | – | – | 1 | 2 | – | – | 2 | 2 | 2 | – | – | – | – | 2 | – | 8 | – | 6 | 13 | – | 5 | 42 | *22·2* |
| 2,500 „ - | 26 | 3 | 2 | 5 | 2 | 3 | 4 | 1 | 1 | 1 | 22 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 2 | – | – | 2 | – | – | 4 | *15·4* |
| 2,000 „ - | 271 | 27 | 25 | 23 | 37 | 26 | 34 | 14 | 30 | 25 | 241 | – | – | – | – | – | 1 | – | – | – | 1 | 1 | – | – | – | 1 | 1 | 2 | – | – | – | 2 | – | 4 | – | 5 | 8 | – | 5 | 29 | *11·1* |
| 1,500 „ - | 82 | 10 | 9 | 7 | 7 | 9 | 9 | 10 | 8 | 6 | 75 | – | – | – | – | – | – | – | – | – | – | – | – | 1 | – | – | 1 | – | – | – | 2 | – | – | – | – | – | – | 3 | 7 | *8·5* |
| 1,000 „ - | 276 | 31 | 29 | 34 | 35 | 24 | 29 | 24 | 25 | 26 | 257 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 1 | 2 | 3 | 6 | 2 | 1 | 1 | 2 | 1 | 19 | *6·9* |
| 500 „ - | 43 | 4 | 2 | 6 | 6 | 1 | 9 | 6 | 3 | 6 | 43 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | — |
| All distances | 892 | 91 | 85 | 92 | 115 | 82 | 106 | 57 | 87 | 74 | 789 | – | – | – | – | – | 2 | – | – | – | 2 | 3 | – | 1 | 2 | 3 | 4 | 2 | – | – | 1 | 8 | 3 | 20 | 2 | 12 | 24 | 2 | 14 | 101 | *11·6* |
| *With Binoculars.* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2,000 yards - | 84 | 7 | 8 | 11 | 6 | 11 | 10 | 6 | 9 | 7 | 75 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 1 | – | 3 | 3 | – | 2 | – | – | – | 9 | *10·7* |
| 1,500 „ - | 26 | 2 | 3 | 3 | 5 | – | 4 | 2 | 1 | 2 | 22 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 2 | – | – | – | – | 1 | – | 1 | 4 | *15·4* |
| All distances with Binoculars | 110 | 9 | 11 | 14 | 11 | 11 | 14 | 8 | 10 | 9 | 97 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 1 | 2 | 3 | 3 | – | 2 | 1 | – | 1 | 13 | *11·8* |

### OBSERVER No. 4.

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| 3,000 yards - | 194 | 19 | 20 | 22 | 30 | 20 | 19 | 15 | 21 | 19 | 185 | – | – | – | – | – | 1 | 1 | – | – | 2 | – | – | – | 1 | – | – | – | 1 | – | – | – | – | – | – | 5 | – | – | 7 | *4·6* |
| 2,500 „ - | 26 | 3 | 2 | 5 | 2 | 3 | 2 | 5 | 1 | 1 | 24 | – | – | – | – | – | 2 | – | – | – | 2 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | *7·7* |
| 2,000 „ - | 276 | 31 | 28 | 29 | 36 | 28 | 32 | 29 | 28 | 32 | 273 | – | – | – | – | – | – | 1 | – | – | 1 | – | – | – | – | – | – | – | – | – | – | – | – | 1 | – | – | – | – | 1 | 2 | *1·1* |
| 1,500 „ - | 54 | 7 | 5 | 7 | 2 | 7 | 8 | 7 | 5 | 6 | 54 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | — |
| 1,000 „ - | 166 | 17 | 16 | 20 | 25 | 14 | 22 | 18 | 16 | 18 | 166 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | — |
| All distances | 716 | 77 | 71 | 83 | 95 | 72 | 83 | 74 | 71 | 76 | 702 | – | – | – | – | – | 3 | 2 | – | – | 5 | – | – | – | 1 | – | – | – | 1 | – | – | – | – | – | 1 | – | – | 5 | – | 1 | 9 | *1·9* |
| *With Binoculars.* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2,000 yards - | 28 | 2 | 4 | 3 | 1 | 4 | 5 | 3 | 3 | 3 | 28 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | — |
| 2,000 „ - (prismatic) | 28 | 2 | 3 | 4 | 1 | 5 | 3 | 3 | 3 | 3 | 27 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 1 | – | – | – | – | – | – | 1 | *3·6* |
| All distances with Binoculars | 56 | 4 | 7 | 7 | 2 | 9 | 8 | 6 | 6 | 6 | 55 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 1 | – | – | – | – | – | – | 1 | *1·8* |

OBSERVER No 5;

| Distance. | Number of Lights shown. | Correctly named. R. 1 | R. 2 | R. 3 | G. 1 | G. 2 | G. 3 | W. 1 | W. 2 | W. 3 | Total correctly named. | Failed to see. R. 1 | R. 2 | R. 3 | G. 1 | G. 2 | G. 3 | W. 1 | W. 2 | W. 3 | Total failed to see. | Incorrectly named. R. called G. 1 | 2 | 3 | R. called W. 1 | 2 | 3 | G. called R. 1 | 2 | 3 | G. called W. 1 | 2 | 3 | W. called R. 1 | 2 | 3 | W. called G. 1 | 2 | 3 | Total incorrectly named. | Percentage of Mistakes (i.e., missed and incorrectly named). |
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| 3,000 yards - | 166 | 10 | 15 | 15 | 14 | 14 | 12 | 6 | 20 | 9 | 115 | 3 | – | – | – | 2 | 1 | – | – | 1 | 7 | 4 | – | 2 | – | 1 | 1 | 9 | 1 | 4 | – | 2 | – | 5 | – | 2 | 9 | – | 4 | 44 | *30·7* |
| 2,500 „ - | 26 | 3 | 3 | 2 | 3 | 2 | 3 | – | 1 | 2 | 19 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 1 | 1 | – | 1 | – | – | – | 1 | – | – | 3 | – | 1 | 7 | *26·9* |
| 2,000 „ - | 271 | 28 | 26 | 26 | 29 | 27 | 32 | 15 | 28 | 25 | 236 | 1 | – | 1 | – | – | – | – | – | – | 2 | – | – | – | – | 2 | 2 | 4 | – | 1 | 2 | – | 1 | 8 | – | 1 | 33 | *12·9* |
| 1,500 „ - | 82 | 6 | 11 | 8 | 11 | 8 | 10 | 8 | 7 | 8 | 77 | – | – | – | – | – | – | – | – | – | – | – | – | – | 1 | – | – | – | 1 | – | – | 1 | – | – | – | 1 | – | 1 | 5 | *6·1* |
| 1,000 „ - | 276 | 28 | 27 | 32 | 37 | 25 | 29 | 25 | 27 | 25 | 255 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 1 | – | 5 | – | 4 | – | 2 | – | 3 | 2 | 4 | 21 | *7·6* |
| 500 „ - | 54 | 3 | 4 | 5 | 3 | 5 | 7 | 6 | 5 | 6 | 44 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 4 | – | 2 | – | 1 | 1 | – | 2 | – | 10 | *18·5* |
| All distances | 875 | 78 | 86 | 88 | 97 | 81 | 93 | 60 | 88 | 75 | 746 | 4 | – | 1 | – | 2 | 1 | – | – | 1 | 9 | 4 | – | 2 | 1 | 3 | 4 | 13 | 3 | 5 | 11 | 4 | 6 | 12 | 3 | 5 | 24 | 4 | 16 | 120 | *14·7* |
| *With Binoculars.* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3,000 yards - | 28 | 3 | 2 | 4 | 5 | 1 | 4 | 3 | 3 | 3 | 28 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| 2,000 „ - | 28 | 2 | 3 | 4 | – | 5 | 4 | – | 2 | 2 | 22 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 1 | – | – | 2 | – | – | 1 | 1 | 1 | 6 | *21·4* |
| All distances with Binoculars | 56 | 5 | 5 | 8 | 5 | 6 | 8 | 3 | 5 | 5 | 50 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 1 | – | – | 2 | – | – | 1 | 1 | 1 | 6 | *10·7* |

OBSERVER No. 6.

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| 3,000 yards - | 194 | 9 | 16 | 15 | 23 | 15 | 11 | 8 | 23 | 14 | 134 | 3 | – | 2 | – | 1 | 2 | – | – | – | 8 | 7 | – | 2 | 1 | 2 | 3 | 4 | 3 | 8 | 1 | 1 | – | 7 | – | 2 | 8 | – | 3 | 52 | *30·9* |
| 2,500 „ - | 26 | 2 | 2 | 2 | 3 | 2 | 3 | 2 | 1 | 2 | 19 | – | – | – | – | – | – | – | – | – | – | – | – | – | 1 | 1 | 1 | – | – | 1 | – | – | – | – | – | – | 2 | – | 1 | 7 | *26·9* |
| 2,000 „ - | 248 | 27 | 25 | 21 | 26 | 25 | 22 | 12 | 24 | 21 | 203 | 1 | – | 1 | 2 | 1 | 1 | 1 | – | 1 | 8 | – | – | 2 | – | 1 | 1 | 3 | 1 | 4 | – | – | 1 | 4 | – | 2 | 11 | 1 | 6 | 37 | *18·1* |
| 1,500 „ - | 82 | 7 | 11 | 8 | 10 | 10 | 9 | 5 | 7 | 6 | 73 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 1 | 1 | – | – | – | – | – | 4 | – | 3 | 9 | *11·0* |
| 1,000 „ - | 276 | 29 | 25 | 25 | 39 | 27 | 31 | 22 | 25 | 30 | 253 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 4 | – | 1 | – | 2 | 1 | 2 | 1 | 1 | – | 5 | 4 | 2 | 23 | *8·4* |
| 500 „ - | 43 | 5 | 2 | 7 | 3 | 3 | 8 | 7 | 1 | 4 | 40 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 1 | 1 | – | – | – | – | 1 | 3 | *7·0* |
| All distances | 869 | 79 | 81 | 78 | 104 | 82 | 84 | 56 | 81 | 77 | 722 | 4 | – | 3 | 2 | 2 | 3 | 1 | – | 1 | 16 | 7 | – | 4 | 2 | 4 | 9 | 7 | 5 | 14 | 4 | 2 | 4 | 13 | 1 | 4 | 30 | 5 | 16 | 131 | *16·9* |
| *With Binoculars.* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3,000 yards - | 28 | 3 | 2 | 4 | 2 | 1 | 3 | 2 | 3 | 3 | 23 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 3 | – | 1 | 1 | – | – | – | – | – | 5 | *17·9* |
| 2,000 „ - | 28 | 3 | 2 | 4 | 5 | 1 | 4 | 2 | 3 | 3 | 27 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 1 | – | – | 1 | *3·6* |
| All distances with Binoculars | 56 | 6 | 4 | 8 | 7 | 2 | 7 | 4 | 6 | 6 | 50 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 3 | – | 1 | 1 | – | – | 1 | – | – | 6 | *10·7* |

OBSERVER No. 7.

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| 3,000 yards - | 84 | – | 6 | 5 | 6 | 5 | 5 | 1 | 6 | 5 | 39 | 5 | – | 1 | 3 | – | 3 | 7 | 1 | 2 | 22 | 1 | 1 | 1 | 1 | – | – | – | – | – | 2 | 4 | 2 | 1 | 1 | 1 | 1 | 4 | 3 | 23 | *59·6* |
| 2,000 „ - | 190 | 7 | 18 | 11 | 19 | 20 | 12 | 8 | 18 | 18 | 131 | 7 | – | 4 | 6 | – | 2 | 4 | – | 2 | 25 | 2 | – | – | 3 | – | 4 | 2 | 1 | – | 2 | 2 | 5 | 1 | 1 | 2 | 6 | 1 | 2 | 34 | *31·1* |
| 1,500 „ - | 82 | 10 | 10 | 5 | 6 | 10 | 7 | 4 | 8 | 4 | 64 | – | – | 1 | 2 | – | 2 | 2 | – | 1 | 8 | – | – | 1 | – | – | 2 | – | – | – | 1 | – | – | 1 | – | 1 | 1 | – | 3 | 10 | *22·0* |
| 1,000 „ - | 276 | 25 | 19 | 25 | 42 | 25 | 31 | 24 | 30 | 31 | 252 | – | 1 | – | – | – | 3 | – | 1 | 1 | 6 | – | 1 | – | – | – | – | – | – | – | 3 | 3 | 2 | 3 | – | 1 | 1 | 4 | – | 18 | *8·7* |
| 500 „ - | 54 | 4 | 4 | 6 | 3 | 5 | 9 | 8 | 3 | 6 | 48 | – | – | – | 1 | 2 | – | – | 1 | – | 4 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 2 | – | 2 | *11·1* |
| All distances | 686 | 46 | 57 | 52 | 76 | 65 | 64 | 45 | 65 | 64 | 534 | 12 | 1 | 6 | 12 | 2 | 10 | 13 | 3 | 6 | 65 | 3 | 2 | 2 | 4 | – | 6 | 2 | 1 | – | 8 | 9 | 9 | 6 | 2 | 5 | 9 | 11 | 8 | 87 | *22·2* |
| *With Binoculars.* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3,000 yards - | 28 | 3 | 4 | 2 | 5 | 4 | 1 | 3 | 3 | 3 | 28 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| 2,000 „ - | 56 | 4 | 7 | 7 | 2 | 9 | 9 | 6 | 6 | 6 | 56 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| All distances with Binoculars | 84 | 7 | 11 | 9 | 7 | 13 | 10 | 9 | 9 | 9 | 84 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |

OBSERVER No. 8.

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| 3,000 yards - | 194 | 15 | 20 | 22 | 22 | 19 | 19 | 15 | 22 | 20 | 174 | 2 | – | – | 6 | – | 5 | 3 | – | – | 16 | – | – | – | – | – | – | – | – | – | – | – | – | 1 | – | – | 2 | – | 1 | 4 | *10·4* |
| 2,500 „ - | 26 | 2 | 2 | 3 | 5 | 1 | 4 | 3 | 3 | 3 | 26 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| 2,000 „ - | 218 | 19 | 24 | 25 | 32 | 24 | 24 | 21 | 24 | 24 | 217 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 1 | – | – | – | – | – | 1 | *·4* |
| 1,500 „ - | 54 | 7 | 6 | 7 | 4 | 6 | 8 | 5 | 5 | 6 | 54 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| 1,000 „ - | 138 | 12 | 12 | 15 | 23 | 8 | 21 | 14 | 15 | 18 | 138 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| All distances | 630 | 55 | 64 | 72 | 86 | 58 | 76 | 58 | 69 | 71 | 609 | 2 | – | – | 6 | – | 5 | 3 | – | – | 16 | – | – | – | – | – | – | – | – | – | – | – | – | 2 | – | – | 2 | – | 1 | 5 | *3·3* |
| *With Binoculars.* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| All distances with Binoculars | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

OBSERVER No. 9.

| Distance. | Number of Lights shown. | Correctly named. R. 1 | R. 2 | R. 3 | G. 1 | G. 2 | G. 3 | W. 1 | W. 2 | W. 3 | Total correctly named. | Failed to see. R. 1 | R. 2 | R. 3 | G. 1 | G. 2 | G. 3 | W. 1 | W. 2 | W. 3 | Total failed to see. | Incorrectly named. R called G. 1 | R called G. 2 | R called G. 3 | R called W. 1 | R called W. 2 | R called W. 3 | G called R. 1 | G called R. 2 | G called R. 3 | G called W. 1 | G called W. 2 | G called W. 3 | W called R. 1 | W called R. 2 | W called R. 3 | W called G. 1 | W called G. 2 | W called G. 3 | Total incorrectly named. | Percentage of Mistakes (i.e., missed and incorrectly named). |
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| 3,000 yards - | 138 | 7 | 16 | 12 | 2 | 9 | 6 | 3 | 15 | 11 | 81 | 4 | – | – | 19 | 7 | 5 | 4 | – | – | 39 | – | – | – | 1 | – | 1 | – | – | – | 2 | 1 | 1 | 5 | – | 3 | 2 | 1 | 1 | 18 | *41·3* |
| 2,500 „ - | 26 | 2 | 2 | 3 | 1 | – | – | 2 | 3 | 1 | 14 | – | – | – | 4 | 1 | 4 | 1 | – | 1 | 11 | – | – | – | – | – | – | – | – | – | – | – | – | – | 1 | – | – | – | 1 | *46·1* |
| 2,000 „ - | 250 | 25 | 24 | 26 | 12 | 26 | 11 | 8 | 25 | 18 | 175 | – | – | – | 22 | 2 | 17 | – | – | – | 41 | – | – | – | – | – | – | – | – | – | 2 | – | – | 19 | 1 | 12 | – | – | – | 34 | *30·0* |
| 1,500 „ - | 54 | 7 | 6 | 7 | 4 | 6 | 7 | 5 | 5 | 6 | 53 | – | – | – | – | – | 1 | – | – | – | 1 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | *1·9* |
| 1,000 „ - | 220 | 22 | 16 | 18 | 36 | 20 | 31 | 21 | 25 | 26 | 215 | – | – | – | – | – | – | – | – | – | – | – | – | 1 | – | – | – | – | – | – | – | – | – | 2 | – | 1 | – | 1 | – | 5 | *2·3* |
| 500 „ - | 26 | 3 | 2 | 4 | 2 | 3 | 4 | 5 | 1 | 2 | 26 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | — |
| All distances | 714 | 66 | 66 | 70 | 57 | 64 | 59 | 44 | 74 | 64 | 564 | 4 | – | – | 45 | 10 | 27 | 5 | – | 1 | 92 | – | – | 1 | 1 | – | 1 | – | – | – | 4 | 1 | 1 | 26 | 1 | 17 | 2 | 2 | 1 | 58 | *21·0* |
| *With Binoculars.* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2,000 yards - | 28 | 2 | 4 | 3 | 1 | 4 | 5 | 3 | 3 | 3 | 28 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | — |
| All distances with Binoculars | 28 | 2 | 4 | 3 | 1 | 4 | 5 | 3 | 3 | 3 | 28 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | — |

OBSERVER No. 10.

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| 3,000 yards - | 245 | 12 | 18 | 12 | 32 | 27 | 20 | 23 | 18 | 13 | 175 | – | – | – | 2 | 1 | 5 | – | 1 | – | 9 | 1 | – | 1 | 9 | 6 | 8 | 1 | – | – | – | – | – | 10 | 6 | 11 | 3 | 1 | 4 | 61 | *28·6* |
| 2,500 „ - | 21 | 2 | 3 | 1 | 2 | 2 | 1 | 3 | 2 | 3 | 19 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 1 | – | – | – | – | – | – | – | 1 | – | – | – | 2 | *9·5* |
| 2,000 „ - | 284 | 17 | 27 | 18 | 41 | 35 | 22 | 27 | 29 | 17 | 233 | – | – | – | – | – | 1 | – | – | – | 1 | 2 | – | 1 | 10 | 5 | 10 | – | – | 1 | 3 | – | 1 | 1 | 1 | 5 | 5 | – | 5 | 50 | *18·0* |
| 1,500 „ - | 84 | 11 | 5 | 8 | 12 | 3 | 15 | 7 | 9 | 8 | 78 | – | – | – | – | – | – | – | – | – | – | 1 | – | – | – | 1 | 1 | – | – | – | – | – | – | – | – | 1 | 2 | – | – | 6 | *7·2* |
| 1,000 „ - | 212 | 18 | 21 | 21 | 28 | 28 | 17 | 19 | 24 | 19 | 195 | – | – | – | – | – | – | – | – | – | – | – | – | – | 1 | – | 1 | – | – | 2 | 3 | – | – | – | – | 5 | 2 | 1 | 2 | 17 | *8·0* |
| 500 „ - | 82 | 8 | 9 | 10 | 7 | 10 | 10 | 11 | 8 | 5 | 78 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 1 | – | 1 | – | – | 2 | – | – | – | 4 | *4·9* |
| All distances | 928 | 68 | 83 | 70 | 122 | 105 | 85 | 90 | 90 | 65 | 778 | – | – | – | 2 | 1 | 6 | – | 1 | – | 10 | 4 | – | 2 | 20 | 12 | 21 | 1 | – | 3 | 7 | – | 2 | 11 | 7 | 25 | 12 | 2 | 11 | 140 | *16·2* |
| *With Binoculars.* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3,000 yards - | 184 | 17 | 20 | 14 | 22 | 20 | 17 | 15 | 17 | 12 | 154 | – | – | – | – | – | – | – | – | – | – | – | – | – | 3 | – | 1 | – | – | – | 3 | 1 | 2 | 8 | 5 | 7 | – | – | – | 30 | *16·3* |
| 2,000 „ - | 166 | 19 | 15 | 20 | 16 | 16 | 21 | 15 | 16 | 13 | 151 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 1 | 1 | – | – | – | 3 | – | 2 | 2 | – | 4 | – | 2 | – | 15 | *9·0* |
| 1,000 „ - | 26 | 2 | 3 | 2 | 5 | 4 | 1 | 3 | 3 | 3 | 26 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | — |
| All distances with Binoculars | 376 | 38 | 38 | 36 | 43 | 40 | 39 | 33 | 36 | 28 | 331 | – | – | – | – | – | – | – | – | – | – | – | – | – | 3 | 1 | 2 | – | – | – | 6 | 1 | 4 | 10 | 5 | 11 | – | 2 | – | 45 | *12·0* |

OBSERVER No. 11.

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| 3,000 yards - | 350 | 38 | 32 | 31 | 56 | 38 | 27 | 40 | 40 | 28 | 330 | – | – | – | 1 | – | 1 | – | – | – | 2 | – | – | – | 2 | 3 | 2 | – | – | – | – | – | – | 7 | 1 | 3 | – | – | – | 18 | *5·7* |
| 2,500 „ - | 43 | 4 | 4 | 2 | 3 | 7 | 2 | 5 | 5 | 5 | 37 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 2 | – | – | – | – | – | – | 2 | – | 2 | – | – | – | 6 | *14·0* |
| 2,000 „ - | 463 | 42 | 52 | 46 | 64 | 59 | 46 | 52 | 52 | 46 | 459 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 1 | – | 3 | – | – | – | 4 | *·9* |
| 1,500 „ - | 28 | 4 | 2 | 3 | 4 | 1 | 5 | 3 | 3 | 3 | 28 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | — |
| 1,000 „ - | 95 | 8 | 7 | 11 | 11 | 12 | 12 | 9 | 14 | 11 | 95 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | — |
| 500 „ - | 28 | 3 | 2 | 4 | 5 | 1 | 4 | 3 | 3 | 3 | 28 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | — |
| All distances | 1,007 | 99 | 99 | 97 | 143 | 118 | 96 | 112 | 117 | 96 | 977 | – | – | – | 1 | – | 1 | – | – | – | 2 | – | – | – | 2 | 3 | 4 | – | – | – | – | – | – | 10 | 1 | 8 | – | – | – | 28 | *3·0* |
| *With Binoculars.* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3,000 yards - | 165 | 14 | 19 | 14 | 23 | 18 | 19 | 23 | 18 | 15 | 163 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 1 | – | – | 1 | 2 | *1·2* |
| 2,500 „ - | 21 | 2 | 2 | 3 | 1 | 2 | 4 | 2 | 4 | 1 | 21 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | — |
| 2,000 „ - | 28 | 4 | 3 | 2 | 4 | 5 | 1 | 3 | 3 | 3 | 28 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | — |
| All distances with Binoculars | 214 | 20 | 24 | 19 | 28 | 25 | 24 | 28 | 25 | 19 | 212 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 1 | – | – | 1 | 2 | *·9* |

OBSERVER No. 12.

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| 3,000 yards - | 190 | 19 | 16 | 21 | 25 | 21 | 21 | 27 | 19 | 21 | 190 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | — |
| 2,000 „ - | 194 | 21 | 19 | 22 | 29 | 21 | 21 | 21 | 21 | 19 | 194 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | — |
| 1,000 „ - | 28 | 3 | 2 | 4 | 5 | 1 | 4 | 3 | 3 | 3 | 28 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | — |
| 500 „ - | 28 | 3 | 2 | 4 | 5 | 1 | 4 | 3 | 3 | 3 | 28 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | — |
| All distances | 440 | 46 | 39 | 51 | 64 | 44 | 50 | 54 | 46 | 46 | 440 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | — |
| *With Binoculars.* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3,000 yards - | 110 | 9 | 10 | 6 | 13 | 16 | 14 | 16 | 12 | 14 | 110 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | — |
| All distances with Binoculars | 110 | 9 | 10 | 6 | 13 | 16 | 14 | 16 | 12 | 14 | 110 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | — |

## OBSERVER No. 13.

| Distance. | Number of Lights shown. | Correctly named. R. 1 | R. 2 | R. 3 | G. 1 | G. 2 | G. 3 | W. 1 | W. 2 | W. 3 | Total correctly named. | Failed to see. R. 1 | R. 2 | R. 3 | G. 1 | G. 2 | G. 3 | W. 1 | W. 2 | W. 3 | Total failed to see. | Incorrectly named. R called G. 1 | R called G. 2 | R called G. 3 | R called W. 1 | R called W. 2 | R called W. 3 | G called R. 1 | G called R. 2 | G called R. 3 | G called W. 1 | G called W. 2 | G called W. 3 | W called R. 1 | W called R. 2 | W called R. 3 | W called G. 1 | W called G. 2 | W called G. 3 | Total incorrectly named. | Percentage of Mistakes (i.e., missed and incorrectly named). |
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| 3,000 yards - | 155 | 16 | 20 | 4 | 18 | 16 | 3 | 17 | 17 | 6 | 117 | – | – | 2 | 7 | 3 | 1 | – | – | 4 | 17 | 1 | – | – | 2 | 1 | 4 | 3 | – | 1 | 1 | 3 | 1 | – | 1 | 2 | 1 | – | – | 21 | *24·5* |
| 2,500 „ - | 21 | 2 | 2 | – | 1 | 1 | 1 | 1 | – | 1 | 9 | – | – | – | – | – | – | – | – | – | – | – | – | 2 | – | 1 | – | – | – | – | 1 | 1 | – | 1 | – | – | 1 | 2 | 3 | 12 | *57·1* |
| 2,000 „ - | 250 | 28 | 30 | 17 | 28 | 34 | 9 | 33 | 32 | 13 | 224 | – | – | – | 5 | – | 4 | – | – | 2 | 11 | – | – | – | – | – | 4 | – | – | 1 | 2 | – | 4 | – | – | 1 | – | – | 3 | 15 | *10·4* |
| 1,000 „ - | 151 | 15 | 17 | 12 | 22 | 22 | 8 | 14 | 20 | 20 | 150 | – | – | – | – | – | 1 | – | – | – | 1 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | *·6* |
| All distances | 577 | 61 | 69 | 33 | 69 | 73 | 21 | 65 | 69 | 40 | 500 | – | – | 2 | 12 | 3 | 6 | – | – | 6 | 29 | 1 | – | 2 | 2 | 2 | 8 | 3 | – | 2 | 4 | 4 | 5 | 1 | 1 | 3 | 2 | 2 | 6 | 48 | *13·3* |
| *With Binoculars.* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3,000 yards - | 70 | 10 | 11 | 2 | 12 | 13 | – | 9 | 8 | 3 | 68 | – | – | – | – | – | 1 | – | – | – | 1 | – | – | – | – | – | – | – | – | – | 1 | – | – | – | – | – | – | – | – | 1 | *2·9* |
| 2,500 „ - | 42 | 4 | 3 | 5 | 2 | 7 | 3 | 6 | 7 | 4 | 41 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 1 | – | – | – | – | – | – | – | 1 | *2·4* |
| 2,000 „ - | 26 | 3 | 4 | 2 | 5 | 4 | – | 3 | 3 | 1 | 25 | – | – | – | – | – | – | – | – | 1 | 1 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | *3·8* |
| All distances with Binoculars | 138 | 17 | 18 | 9 | 19 | 24 | 3 | 18 | 18 | 8 | 134 | – | – | – | – | – | 1 | – | – | 1 | 2 | – | – | – | – | – | – | – | – | – | 1 | – | 1 | – | – | – | – | – | – | 2 | *3·0* |

## OBSERVER No. 14.

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| 3,000 yards - | 237 | 28 | 23 | 13 | 30 | 26 | 12 | 29 | 29 | 23 | 213 | – | – | 3 | 4 | 3 | 8 | – | – | 1 | 19 | – | – | 1 | 1 | – | – | – | 1 | – | – | 1 | – | – | – | – | 1 | – | – | 5 | *10·2* |
| 2,500 „ - | 22 | 1 | 1 | 1 | – | 4 | 1 | 3 | 2 | – | 13 | – | – | – | – | 1 | – | – | – | – | 1 | – | – | – | 1 | – | 1 | – | – | – | 1 | – | – | 1 | – | 1 | – | 1 | 2 | 8 | *40·9* |
| 2,000 „ - | 260 | 31 | 24 | 28 | 34 | 27 | 22 | 30 | 32 | 24 | 252 | – | – | – | – | – | 7 | – | – | 1 | 8 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | *3·1* |
| 1,500 „ - | 28 | 4 | 2 | 3 | 4 | 1 | 5 | 3 | 3 | 3 | 28 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | — |
| 1,000 „ - | 124 | 13 | 11 | 15 | 13 | 14 | 15 | 14 | 17 | 12 | 124 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | — |
| All distances | 671 | 77 | 61 | 60 | 81 | 72 | 55 | 79 | 83 | 62 | 630 | – | – | 3 | 4 | 4 | 15 | – | – | 2 | 28 | – | – | 1 | 2 | – | 1 | – | 1 | – | 1 | 1 | – | 1 | – | 1 | 1 | 1 | 2 | 13 | *6·1* |
| *With Binoculars.* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3,000 yards - | 104 | 11 | 9 | 6 | 14 | 14 | 11 | 10 | 12 | 16 | 103 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 1 | 1 | *1·0* |
| 2,000 „ - | 54 | 4 | 7 | 6 | 3 | 9 | 7 | 8 | 5 | 4 | 53 | – | – | – | – | – | – | – | – | – | – | – | – | – | 1 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 1 | *1·9* |
| All distances with Binoculars | 158 | 15 | 16 | 12 | 17 | 23 | 18 | 18 | 17 | 20 | 156 | – | – | – | – | – | – | – | – | – | – | – | – | – | 1 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 2 | *1·3* |



## OBSERVER No. 15.

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| 3,000 yards - | 127 | 16 | 12 | 7 | 20 | 17 | 9 | 15 | 9 | 10 | 115 | – | – | 1 | – | 1 | 1 | – | – | – | 3 | – | – | – | – | – | 1 | – | – | – | – | – | – | 1 | 1 | 1 | – | 2 | 3 | 9 | *9·5* |
| 2,000 „ - | 179 | 18 | 19 | 20 | 27 | 19 | 18 | 24 | 16 | 18 | 179 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | — |
| 1,000 „ - | 110 | 12 | 14 | 8 | 19 | 17 | 4 | 12 | 12 | 12 | 110 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | — |
| All distances | 416 | 46 | 45 | 35 | 66 | 53 | 31 | 51 | 37 | 40 | 404 | – | – | 1 | – | 1 | 1 | – | – | – | 3 | – | – | – | – | – | 1 | – | – | – | – | – | – | 1 | 1 | 1 | – | 2 | 3 | 9 | *2·9* |
| *With Binoculars.* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3,000 yards - | 124 | 16 | 13 | 11 | 19 | 14 | 7 | 14 | 17 | 11 | 122 | – | – | – | – | – | 2 | – | – | – | 2 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | *1·6* |
| 2,000 „ - | 26 | 3 | 3 | 3 | 3 | 4 | 2 | 4 | 3 | 1 | 26 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | — |
| All distances with Binoculars | 150 | 19 | 16 | 14 | 22 | 18 | 9 | 18 | 20 | 12 | 148 | – | – | – | – | – | 2 | – | – | – | 2 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | *1·3* |

## OBSERVER No. 16.

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| 3,000 yards - | 232 | 27 | 24 | 8 | 27 | 26 | 6 | 25 | 28 | 20 | 191 | – | – | 1 | 6 | 2 | 14 | – | – | 2 | 25 | – | – | – | – | – | 3 | – | – | – | 3 | 3 | – | 2 | – | 2 | 3 | – | – | 16 | *17·7* |
| 2,500 „ - | 18 | – | 2 | – | 1 | – | 1 | – | 2 | 1 | 7 | – | – | 3 | – | – | – | – | – | – | 3 | 1 | – | – | 1 | – | – | – | 1 | – | – | 1 | – | – | 1 | – | 2 | 1 | – | 8 | *61·1* |
| 2,000 „ - | 240 | 28 | 23 | 25 | 30 | 24 | 18 | 27 | 27 | 20 | 222 | – | – | – | 2 | – | 9 | – | – | – | 11 | – | – | 1 | – | – | 1 | – | – | – | 1 | – | – | 1 | – | – | – | 1 | 2 | 7 | *7·6* |
| 1,500 „ - | 28 | 4 | 2 | 3 | 4 | 1 | 5 | 3 | 3 | 3 | 28 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | — |
| 1,000 „ - | 124 | 13 | 11 | 15 | 13 | 14 | 15 | 14 | 17 | 12 | 124 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | — |
| All distances | 642 | 72 | 62 | 51 | 75 | 65 | 45 | 69 | 77 | 56 | 572 | – | – | 4 | 8 | 2 | 21 | – | – | 2 | 39 | 1 | – | 1 | 1 | – | 4 | – | 1 | – | 4 | 4 | – | 3 | 1 | 2 | 5 | 2 | 2 | 31 | *10·9* |
| *With Binoculars.* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3,000 yards - | 96 | 11 | 10 | 7 | 11 | 17 | 9 | 11 | 8 | 9 | 293 | – | – | – | 1 | – | – | – | – | – | 1 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 1 | – | 1 | 2 | *3·1* |
| 2,000 „ - | 28 | 2 | 3 | 4 | 1 | 5 | 4 | 3 | 3 | 3 | 28 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | — |
| All distances with Binoculars | 124 | 13 | 13 | 11 | 12 | 22 | 13 | 14 | 11 | 12 | 121 | – | – | – | 1 | – | – | – | – | – | 1 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 1 | – | 1 | 2 | *2·4* |

OBSERVER No. 17.

| Distance. | Number of Lights shown. | Correctly named. R. 1 | R. 2 | R. 3 | G. 1 | G. 2 | G. 3 | W. 1 | W. 2 | W. 3 | Total correctly named. | Failed to see. R. 1 | R. 2 | R. 3 | G. 1 | G. 2 | G. 3 | W. 1 | W. 2 | W. 3 | Total failed to see. | Incorrectly named. R called G. 1 | R called G. 2 | R called G. 3 | R called W. 1 | R called W. 2 | R called W. 3 | G called R. 1 | G called R. 2 | G called R. 3 | G called W. 1 | G called W. 2 | G called W. 3 | W called R. 1 | W called R. 2 | W called R. 3 | W called G. 1 | W called G. 2 | W called G. 3 | Total incorrectly named. | Percentage of Mistakes (i.e., missed and incorrectly named). |
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| 3,000 yards - | 44 | 7 | 5 | – | 9 | 8 | – | 4 | 8 | – | 41 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 2 | 1 | – | 3 | 6·8 |
| 2,000 „ - | 66 | 9 | 12 | – | 14 | 9 | – | 5 | 8 | – | 57 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 1 | – | 1 | 2 | – | 2 | – | – | 2 | 1 | – | 9 | 13·6 |
| All distances | 110 | 16 | 17 | – | 23 | 17 | – | 9 | 16 | – | 98 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 1 | – | 1 | 2 | – | 2 | – | – | 4 | 2 | – | 12 | 10·9 |
| *With Binoculars.* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3,000 yards - | 22 | 3 | 4 | – | 5 | 4 | – | 3 | 3 | – | 22 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | — |
| All distances with Binoculars | 22 | 3 | 4 | – | 5 | 4 | – | 3 | 3 | – | 22 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | — |

OBSERVER No. 18.

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| 3,000 yards - | 44 | 6 | 6 | – | 9 | 8 | – | 7 | 8 | – | 44 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | — |
| 2,000 „ - | 66 | 9 | 12 | – | 15 | 12 | – | 9 | 9 | – | 66 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | — |
| All distances | 110 | 15 | 18 | – | 24 | 20 | – | 16 | 17 | – | 110 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | — |
| *With Binoculars.* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3,000 yards - | 22 | 3 | 4 | – | 5 | 4 | – | 3 | 3 | – | 22 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | — |
| All distances with Binoculars | 22 | 3 | 4 | – | 5 | 4 | – | 3 | 3 | – | 22 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | — |

OBSERVER No. 19.

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| 3,000 yards - | 44 | 6 | 6 | – | 9 | 8 | – | 7 | 8 | – | 44 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | — |
| 2,000 „ - | 88 | 12 | 16 | – | 20 | 16 | – | 12 | 12 | – | 88 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | — |
| All distances | 132 | 18 | 22 | – | 29 | 24 | – | 19 | 20 | – | 132 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | — |
| *With Binoculars.* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3,000 yards - | 22 | 4 | 1 | – | 4 | 4 | – | 3 | 6 | – | 22 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | — |
| All distances with Binoculars | 22 | 4 | 1 | – | 4 | 4 | – | 3 | 6 | – | 22 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | — |

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| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | *Per cent.* |
| 3,000 yards - | 40 | 6 | 5 | – | 6 | 8 | – | 6 | 6 | – | 37 | – | – | – | – | – | – | – | – | – | – | – | 1 | – | 1 | – | – | 1 | – | – | – | – | – | – | – | – | – | – | 3 | 7·5 |
| 2,000 „ - | 66 | 9 | 12 | – | 15 | 12 | – | 9 | 9 | – | 66 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | — |
| All distances | 106 | 15 | 17 | – | 21 | 20 | – | 15 | 15 | – | 103 | – | – | – | – | – | – | – | – | – | – | – | 1 | – | 1 | – | – | 1 | – | – | – | – | – | – | – | – | – | – | 3 | 2·8 |
| *With Binoculars.* | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3,000 yards - | 22 | 4 | 1 | – | 4 | 4 | – | 3 | 6 | – | 22 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | — |
| All distances with Binoculars | 22 | 4 | 1 | – | 4 | 4 | – | 3 | 6 | – | 22 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | — |

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