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LIGHT-HOUSE ESTABLISHMENT.

INSTRUCTIONS AND DIRECTIONS

TO

LIGHT KEEPERS.

SEPTEMBER, 1871.



SIXTH EDITION.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1871.

1871

LIGHT-HOUSE BOARD OF THE UNITED STATES.

Organized in conformity to the act of Congress approved August 31, 1852.

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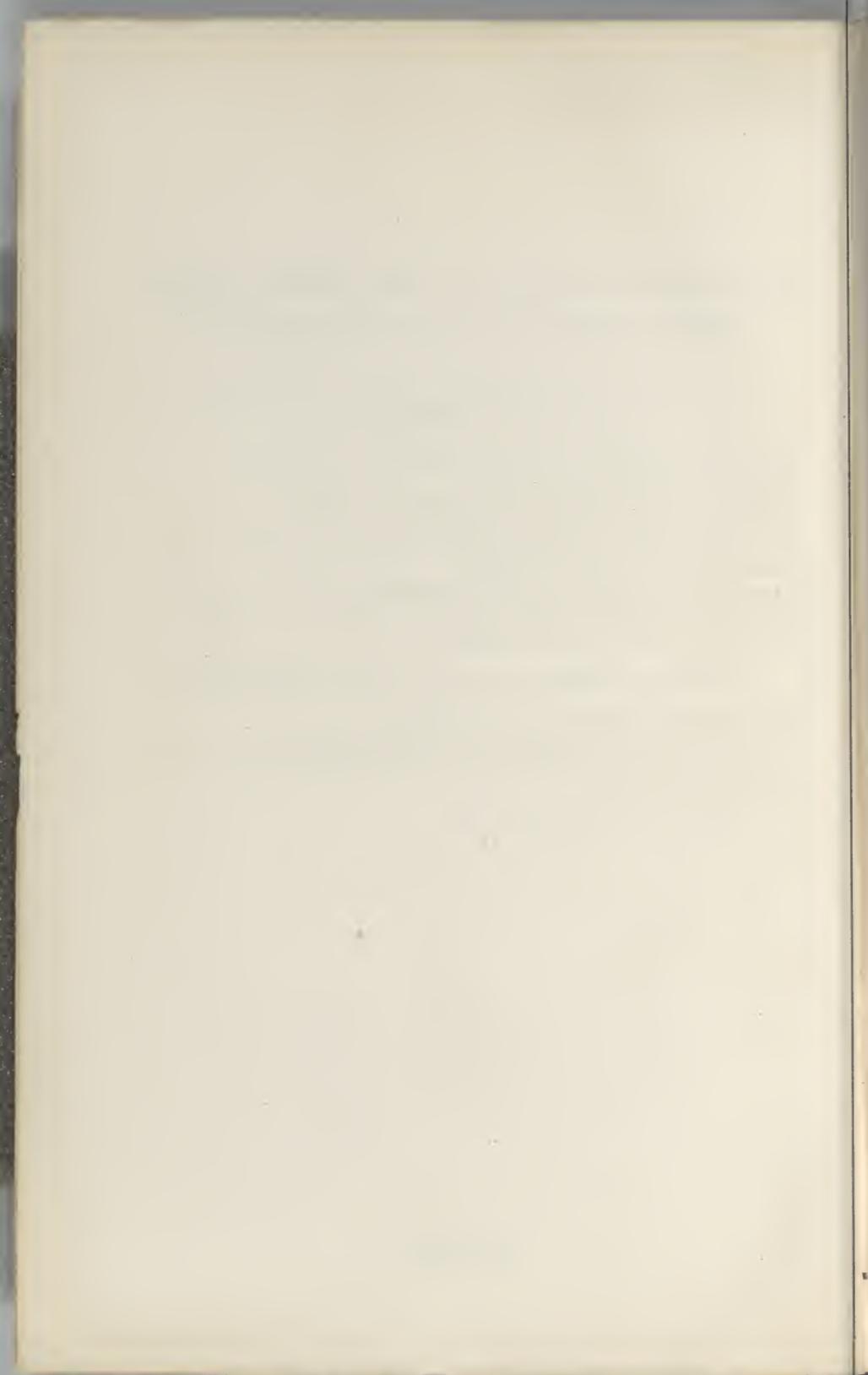
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TREASURY DEPARTMENT,

Office Light-house Board, September, 1871.



NOTICE.

The following Instructions and Directions are published for the guidance of Light Keepers. They are required to read them carefully and attentively, and to refer to them whenever they have any doubts in regard to their duties, or the manner of performing them.

Each keeper and assistant keeper will be furnished with a copy, *to be kept and used at the light-stations* where they are employed; to be handed over to their successors when they are relieved or discharged, or left at the light-stations in case there should be no successors.

Each light-vessel keeper will be provided with two copies for the use of himself and those of the crew who are charged with the management of, and attendance upon, the lights and fog-signals. :

Neither this *Book of Instructions and Directions*, nor the *Placards*, are to be removed from the light-stations or light-vessels, but are to be kept where they can be readily referred to at any time.

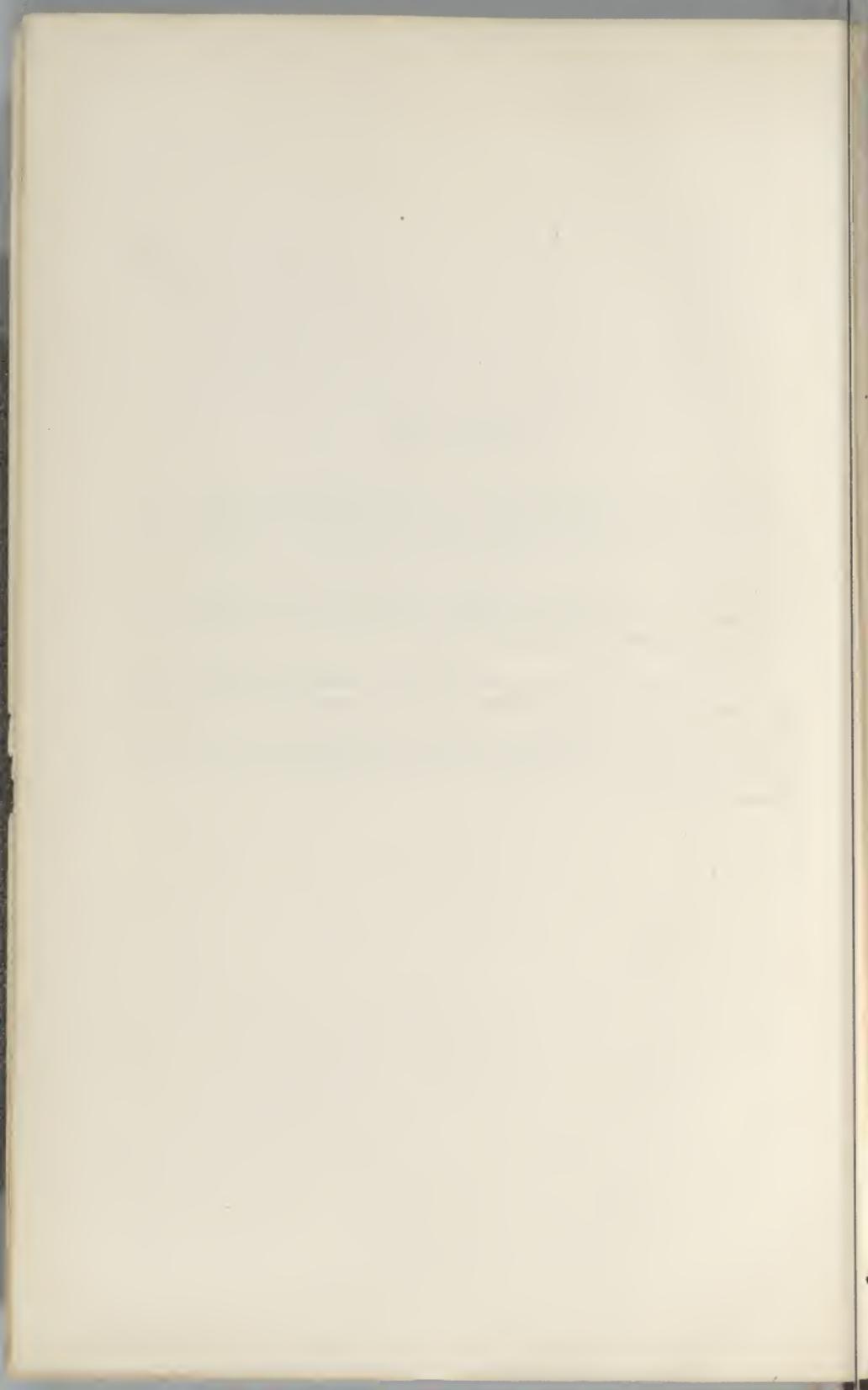


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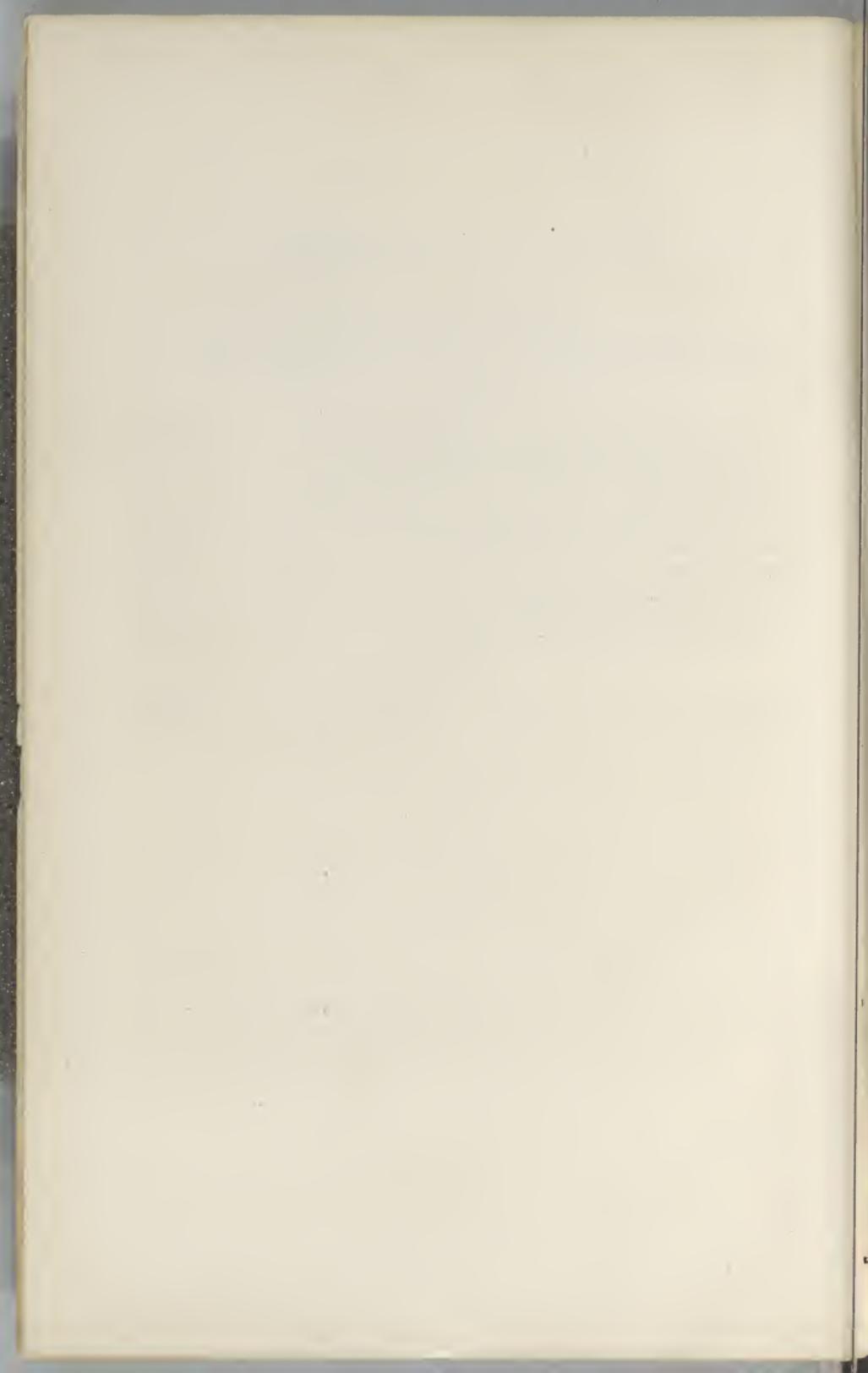
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INSTRUCTIONS

TO

LIGHT-HOUSE AND LIGHT-VESSEL KEEPERS.

LIGHTING LAMPS.

1. *The light-house and light-vessel lamps shall be lighted and the lights exhibited for the benefit of mariners punctually at sunset, daily.*

2. *Light-house and light-vessel lights are to be kept burning brightly, free from smoke, and at their greatest attainable heights, during each entire night from sunset to sunrise, as prescribed by article XXVI of the directions, and as shown by the drawings of the fully developed flames, (see plates;) the height of the flame to be frequently measured during each watch at night, by the scale graduated by inches and tenths of an inch with which keepers will be provided.*

3. In order that the light may be uniformly maintained, at all times during their exhibition, at their greatest heights and with their greatest brilliancy, the keepers are required to be unremitting in their attention to the illuminating apparatus, plate glass of the lanterns, lamps, wicks, chimneys, ventilation, and dampers, and see—

a. That the whole of the illuminating apparatus and the plate glass of the lantern are perfectly clean, and free from dampness at the time of lighting the lamp in the evening, and that they are kept in that state during the entire exhibition of the light, by dusting with the feather brushes, and wiping with clean linen towels, frequently during each watch, if necessary.

b. That the lamp is properly placed on its stand, and the burner accurately adjusted in the centre of the lens, with the top or crown of the burner at the exactly prescribed distance for the order of apparatus, below the focal plane of the apparatus, viz:

For a 1st order lens, one and one tenth ($1\frac{1}{10}$) inch;

For a 2d order lens, one (1.0) inch;

For a 3d order lens, ninety-four hundredths ($\frac{94}{100}$) of an inch; and,

For 4th, 5th, and 6th order lenses, eighty-seven hundredths ($\frac{87}{100}$) of an inch.—(See directions XXXV.)

c. That the wicks have been properly fitted and trimmed; free from burnt or charred edges, inequalities, and loose projecting threads; and after they are all burning well, that they are gradually raised to the prescribed and required height for producing a clear bright light of the prescribed height of flame for the particular order of apparatus and lamp, viz:

For a 1st order 4 wicks burner, maximum height of flame above the top of the burner, about 100 millimeters = $3\frac{93}{100}$ inches;

For a 2d order 3 wick burner, maximum height of flame above the top of the burner, about 80 millimeters = $3\frac{15}{100}$ inches;

For a 3d order (large model) 2 wicks burner, maximum height of flame above the top of the burner, about 70 millimeters = $2\frac{3}{4}$ inches;

For a 3d order (small model) 2 wicks burner, maximum height of flame above the top of the burner, about 65 millimeters = $2\frac{5}{100}$ inches;

For a 4th order (large model) 1 wick burner, maximum height of flame above the top of the burner, about 45 millimeters = $1\frac{3}{4}$ inch;

For a 4th order (small model) 1 wick burner, maximum height of flame above the top of the burner, about 37 millimeters = $1\frac{4}{100}$ inch.—(See directions XIV and XVII.)

d. That the glass chimney is free from smoke, stains of oil, soot, grease, dampness, dust, and dirt; and that it is perfectly clear, free from wavy or striated appearances; sets straight and steady in its holder, and the holder raised to the proper height for producing with the aid of the damper (properly managed) the best possible light as regards color and height of flame.—(See directions, articles XI, XXII, XXIII, and XXIV.)

“The ventilation of the lantern forms a most important element in the preservation of a good and efficient light. An ill-ventilated lantern has its sides continually covered with the water of condensation, which is produced by the contact of the ascending current of heated air; and the glass thus obscured obstructs the passage of the rays, and diminishes the power of the light.” * * * * * “Ventilators capable of being opened and shut at pleasure, so as to admit from without a supply of air when required, are provided in the parapet-wall on which the lantern stands; the lantern roof also is surmounted by a cover which, while it closes the top of an open cylindric tube against the entrance of rain, and descends over it only so far as is needful for that purpose, still leaves an open air-space between it and the dome. This arrangement permits the current of heated air, which is continually flowing from the lantern through the cylindric tube, to pass between it and the outer cover, from which it finally escapes to the open air through the space between the cover and the dome.”

“The ventilating pipe or chimney is a copper tube.” * * * * *

e. Ventilation of lantern. Before commencing the lighting of the lamp, a sufficient number of the ventilators are to be opened to produce a proper draught, and after the lamp is fairly burning, regulate the number and openings to suit the then state of the atmosphere, and change, by opening or shutting, to suit during the entire night. One of the first duties of light keepers, upon entering light-house lanterns in the evening preparatory to lighting the lamps, will be to give their particular attention to the condition of the ventilators, and to the proper ventilation of the lantern, to insure steady and bright lights.—(See directions XIX.)

f. Regulate the damper as changes in the flame take place.

4. The *wicks* must be trimmed as often as may be found to be necessary to insure a *steady, unbroken flame of uniform shape*, and of the prescribed or greatest attainable height, while free from smoky points, and flickerings.

a. The mechanical and other overflow lamps, used in lens apparatus, being constructed to give an overflow of at least four times the quantity of oil consumed, the wicks (when properly attended to at first lighting) char slowly, and the lamp ought to burn with good colza, sperm, or lard oil during the entire night* without requiring the wicks to be trimmed or even touched.—(See directions III, XIV, and XX.)

* Mechanical and other overflow lamps will burn 15 to 16 hours steadily without requiring the wicks to be trimmed.

5. The *glass chimneys* must be kept carefully adjusted by the chimney holders, and the dampers opened or closed to suit the heights of the flames, under the varying circumstances of the weather, draught of air, and gradual increase of height of flame after first lighting in the evening.

6. The *glass chimneys* must be entirely free from dust, stains, smoke, and dampness when placed in the chimney holders of the lamps; and in case they become damp, dingy, smoked, or otherwise soiled, they must be removed *immediately* and clean ones used in their stead. (See directions for attendance upon lights.—See directions XI and XXII.)

EXTINGUISHING LIGHTS.

7. All *light-house and light-vessel lights* shall be extinguished *punctually at sunrise*, and everything put in order for lighting in the evening by 10 o'clock a. m., daily.—(See directions I, II, III, IV, V, VI, and VII.)

8. Light keepers are responsible, and will be held to a strict accountability for any neglect of their duties. They are required to keep a careful watch over, and see that the lights under their care are kept properly trimmed throughout each night; and during stormy and thick weather those keepers who have no assistants must attend in the lanterns and watch the lights during the entire night, and omit no proper efforts to keep the lights burning at their greatest effective power.—(See instructions, Nos. 2 and 3, *a, b, c, d, e, and f.*)

9. Light keepers will note in their journals immediately after exhibiting their own lights in the evening, and not later than at the end of twilight, the names of such light-houses, lighted beacons, and light-vessels' lights, as may be visible from their light-house lanterns or balconies, specifying in each case how the lights appeared; whether bright, faint, or dingy-looking, with the kind of weather, and state of the atmosphere; whether rainy, stormy, clear, snowy, or thick; and in case any light is not visible that is ordinarily or ought to be seen, *that fact is to be specially recorded in the journal, and reported by letter to the inspector immediately.* The time of the disappearance of any light that ought to be seen must also be carefully recorded and reported to the Inspector immediately, with the particular state of the weather at the time the light was missed.

10. *Drift snow, ice, sleet, and moisture on the lantern-glass.*—Unremitting attention must be given to the lantern-glass during the exhibition of the lights at all times, but especially during bad weather.—(See directions XLII.)

11. *Revolving machinery.*—The revolving machinery of all movable lights must be perfectly clean in every part, free from dust, well oiled with clock oil, uniform in its motions, regular in its times of revolutions as prescribed,* and free from extraordinary friction of its parts at the time it is put in motion. The revolving machines are to be wound up at the expiration of regular intervals of time during the exhibition of the lights, to insure the greatest attainable uniformity of motion.—(See directions IX, XVIII, XXVIII, XXIX, XXX, XXXI, XXXII, XXXIII, XXXIV, and LXX.)

12. When a movable light is extinguished in the morning, *the machine must be wound up, and the motive weight allowed to rest upon a support* until the time for lighting in the evening, to relieve the machinery from

* To be verified daily by clock or "time marker" provided for the purpose.

the unnecessary pressure of the weight, and to prevent the possibility of the parting of the cord.—(See Directions IX.)

13. *Stormy and thick weather.*—During stormy and thick weather light keepers are required to give their whole time and constant attention to the lights in their charge; to keep the flames at their greatest attainable height, burning brightly and steadily, and the lantern-glass free inside and outside of moisture. During heavy gales of wind, snow, rain, and hail storms, the lights must never be left unattended by a keeper. Storm panes for replacing broken glass of the lantern must be kept at hand ready for instant use, and when required, put in place without unnecessary delay. The ventilators must be closely watched during storms, so that a proper draught may be kept in the lantern as the wind varies in force and direction, without flaring and flickering of the flame.—(See directions XIX, XLIII.)

14. Light keepers are responsible, and will be held to a strict accountability, for the proper care, preservation, and good order of the illuminating apparatus, lamps, burners, machinery, utensils, buildings and their appurtenances, and for the faithful and economical use of the light-house and light-vessel supplies of every kind and description placed in their charge. They are required to practice the strictest economy in the use of oil, wicks, chimneys, and cleaning materials, compatible with the paramount duty of maintaining at all times the best possible lights their apparatus will produce, and to be careful to prevent waste, theft, and misapplication of all light-house and light-vessel property intrusted to their care and management.—(See directions XLVI.)

15. A journal or log and expenditure book must be kept at each light-station, showing the daily expenditure of oil, wicks, chimneys, and the state of the weather during the exhibition of the light. All expenditures of oil, wicks, and chimneys will be entered *at the time they are made*. The expenditure returns of oil, wicks, and chimneys will be made out from the expenditure journal, and transmitted to the light-house inspector of the district at the end of each quarter-year, viz., December 31, March 31, June 30, and September 30. These returns must be accurate copies of the entries in the journal of expenditures.—(See Form No. 45.)

16. Annual returns of receipts, expenditures, and of apparatus and fixtures, will be made in duplicate according to the prescribed forms, 48 A and 48 B. These returns will be made up annually to the 30th of June, when one copy must be transmitted to the Light-house Inspector of the district, one copy to be retained at the light-station for reference.—(See Forms.)

17. Light keepers are required to keep the stairways, landings, windows, window recesses, watch-rooms, oil-rooms, store-rooms, closets, and all parts of the interiors of dwellings and kitchens, clean and neat. They are also required to give their attention to the preservation of dikes, fences, landing-places, boat-ways and houses, drains, &c., and to the premises generally in their charge, to the end that they shall, at all times, be in good order and condition.

18. Light keepers are strictly forbidden to keep, or allow to be kept, COAL OIL, KEROSENE, OR ANY OTHER INFLAMMABLE OIL, lucifer matches, greasy rags or cloths, or any other articles of a combustible character, about the premises, where they might by accident or by spontaneous combustion become ignited.

19. Fires and lights are not to be left in apartments, *unattended, at any time.*

20. Uncovered lights are not to be used in store-rooms or closets. When it becomes necessary to enter a store-room or closet with a light, it must be kept in a close lantern.

21. Every possible precaution must be taken to guard against the injury or destruction of the public buildings and other property by fire. Fire-buckets, when provided, are to be kept filled with water, ready for use, and they must not be removed from their proper places, or used for any other purpose than the extinguishment of fire.

22. Light keepers are forbidden to use, or allow to be used, any other materials for cleaning and polishing the lens apparatus and plate-glass of the lanterns than the *dusting and feather brushes, rouge powder, prepared whiting, spirits of wine, buff or chamois skins, and linen cleaning cloths* authorized and supplied by direction of the Light-house Board, and in the manner prescribed by the directions to light keepers.

23. Light keepers must be of *good character, of sober and industrious habits*, and they are required to comport themselves in an orderly and proper manner in their families, and at the light-stations to which they are attached.

24. Light keepers are prohibited from carrying on any business or trade which will or might require them to be often absent from the premises in their charge, or which would cause them to neglect in any way their proper duties as light-keepers.

25. Light keepers are forbidden *to sell, or allow to be sold*, on the premises in their charge, or to which they belong, any malt, vinous, spirituous, or other intoxicating drinks or liquors; *nor will they be allowed to permit any intoxicated person, or any one under the influence of intoxicating drinks*, to enter a light-house tower; or any one in that condition, who may visit the station, to remain longer than may be absolutely necessary to get rid of him by the employment of all proper and reasonable means.

26. Light keepers are expected and required *to be courteous and polite to all visitors who conform to the regulations*, and otherwise behave in a proper manner. They will show them the illuminating apparatus, buildings, and any other objects of interest, *at such times as may not seriously interfere with their light-station duties*; but visitors must not be permitted to handle the apparatus or utensils, nor to mark the plate-glass, walls, doors, windows, or railings, nor to soil or deface anything on the premises. *Special care must be taken to prevent visitors from scratching their names or initials with diamond ornaments upon the glass of the lantern, the apparatus, and windows of the towers. This is an imperative duty, and must not be neglected.*

27. *Visitors must not be admitted into light-towers or lanterns unattended by a keeper.* The number of visitors proper to be admitted into a lantern at one time must be determined by the principal or attending keeper, who will be guided by the capacity of the lantern and a due regard to the protection of the apparatus against injury from contact and overcrowding. At light-stations situated near cities, towns, or watering-places, if necessary, *the inspector of the district may authorize the keepers to post a notice on the premises informing visitors at what hours they may be admitted to the towers and lanterns, so as not to interfere with the regular and proper exhibition of the lights. Visitors are not to be admitted into lanterns between sunset and sunrise as a general rule*, but, should it become necessary to depart from this rule at any time, for

special and sufficient reasons, keepers must be careful to see that they do not obstruct the lights by placing themselves between the light and the sea side of it. *No charge is to be made, and no fee to be received, by any keeper for admitting visitors to light-houses.*

28. When supplies or stores of any kind are to be delivered at any light-station, *all the light keepers present shall attend and assist in receiving, handling, and caring for them.* The keeper, or if there be more than one keeper, the principal keeper must, by examination, and careful scrutiny, satisfy himself that the articles delivered are in good condition, and of the quantity or quantities stated in the lists furnished by the person making the deliveries. *Keepers are forbidden to sign receipts for articles until they shall have carefully compared the deliveries with the lists, and satisfied themselves of their correctness.* All articles of every description received at a light-station are to be entered without avoidable delay in the account of supplies and expenditures books.

29. At the end of the quarter year next after the delivery of the annual supplies at a light-station, and after sufficient time shall have elapsed to enable the keeper to determine their quality, a special return and report of the quality and quantity of all the articles received must be carefully made out and forwarded by mail, or delivered by hand, to the Light-house Inspector of the district for examination and file. In case any important article of lighting stores is found to be of bad quality at any time after receiving it, keepers will lose no time in reporting the facts to the Light-house Inspector. This special report on the quality and quantities of supplies received will embrace a complete inventory of all articles of supply on hand at the date it is made out, as may be shown by the books of the keeper.

30. Light keepers are required to make a careful examination of all *rouge powder, whiting, and other cleaning materials,* immediately after receiving them, and to be particular in preventing them from being kept where they may become injured by dampness or dust. Rouge powder and whiting are not to be used in cleaning and polishing the apparatus and plate-glass until they shall have been thoroughly and fully prepared for use as directed.—(See directions.)

31. Should it appear, or be discovered at any time by the keepers, that any article or articles of illuminating supplies is or are running short, either from loss, inferior quality, or miscalculation, and that the regular and proper exhibition of the light may be prevented thereby before the regular period for the arrival of the annual supplies, the facts must be reported immediately to the Inspector of the district, who will supply the deficiencies or report the facts to the Light-house Board. Keepers placed in such circumstances must not neglect any proper means to keep their lights exhibited until the deficient articles are sent to them.

32. All wrecks that take place within the vicinity of lights must be reported promptly by their respective keepers according to the prescribed form. It will be the duty of light-keepers to aid wrecked persons as far as it may lie in their power. They will make diligent inquiries in regard to these wrecks, ascertaining, if possible, from survivors, whether or not the light was seen before the vessel struck, and and at what time, and state the facts in the wreck report, to be forwarded to the Inspector for transmission to the Board.

33. Light keepers are required to remain at the stations in their charge, and to which they belong, as continuously as possible, *absenting themselves from the premises only on such occasions and at such times*

as are allowed by the regulations, or when it is indispensably necessary for them to do so. They are authorized to leave their stations to attend public worship on Sundays; to receive their quarterly salaries; to procure needful supplies for themselves and families; and on important special public occasions; but as no specific rules can be established limiting the times and durations of keepers' absences, they will be held strictly accountable for any abuse or misuse of the discretion given to them in this regard. No keeper will be excused who is absent from his duties at night (from half an hour before sunset to daylight next morning) without having previously made ample and undoubtedly effective arrangements for the proper exhibition of the light or lights in his charge, or to which he is attached, during his absence, by a person or persons belonging to the light-station. In cases of sickness, keepers are required to provide proper attendants for the lights; but should it happen that the keeper or keepers of a light-station is or are incapacitated, or is or are likely to become incapacitated, from any cause, for the faithful performance of his or their duties, the Inspector of the district and the nearest Collector of customs to the light-station must be informed immediately of the necessity for assistance. A report of every absence and its duration must be made in the prescribed form and transmitted to the Inspector on the last day of each month, and any failure to make these reports, and correctly, will subject the keeper to removal.

34. Light keepers are to render every assistance in their power to all Light-house Establishment officers and others who may visit the stations to which they are attached. Inspectors and Engineers are authorized to require from all persons at light-stations, if not readily procurable elsewhere, such labor, materials, and assistance in making repairs, &c., as they may be able to perform and furnish, for which proper compensation will be allowed by them.

35. It will be the duty of light keepers to assign a proper part of their dwellings when required, and to furnish food to all persons who may visit light-stations as Engineers, Inspectors, Lampists, &c. Reasonable compensation will always be made to keepers for boarding officers and others thus circumstanced, but extortionate charges will not be paid or allowed.

36. Lampists and other mechanics, when visiting light-stations for the purpose of repairing lamps and machinery, adjusting apparatus, and for giving practical instruction to the keepers in their duties, will be provided by the keepers with lodging and board, if required, during their stay at the stations, for which reasonable compensation will be made, and, in case excessive or exorbitant charges are made by keepers, it will be the duty of the party to bring the matter to the attention of the Inspector or Engineer, who will ask instructions from the Light-house Board, if necessary.

37. Light keepers and all assistant keepers must attend with the Lampists, or other persons employed, while the apparatus is being set up, adjustments are being made to the apparatus, and for instruction, and pay proper attention to the instructions they may receive upon all matters relating to their duties as light-keepers.

STATIONS WITH TWO OR MORE KEEPERS.

38. Light keepers at light-stations where there are two or more keepers are required to keep regular watches in the lanterns and watch-

rooms during the entire periods of exhibitions of the lights at night. The first watch will commence at the time of lighting the lights at sunset in the evening.

39. Watches are to be alternate, so that the keeper who has the watch from 8 o'clock to midnight shall on the next succeeding night have the watch from midnight to 4 a. m. In dividing the time for watches from 8 p. m. to 4 a. m., it, as a general rule, should be, for the four hours from 8 to midnight, and from midnight to 4 a. m., but under no circumstances should a regular watch exceed four hours' duration. The length of time to be on watch before 8 p. m., and after 4 a. m., will depend upon the seasons of the year. The watches of light keepers must be arranged so that the keeper who has been in charge of the light from 8 p. m. to midnight must be punctually relieved by another keeper at midnight. From the 1st day of October to the 31st March, inclusive, the keeper who has had the watch from sunset to 8 p. m. must be punctually relieved by another keeper at 8 p. m.

40. At light-stations with two or more keepers the principal keeper is responsible for the entries required to be made in the journals and expenditure books; for the proper exhibition of and attendance upon the lights by the assistants as well as by himself; for the proper issue and economical use of the oil, wicks, chimneys, and all other articles of supply; for the general care and preservation of and attention to the entire premises, and for the faithful performance of the duties required of the assistant keepers.

41. At light-stations where there are two or more towers, or separate and distinct lights of the same order in different lanterns, the assistant keepers may, if the number will admit of it, be assigned to special lights or lanterns, under the general supervision of the principal keeper; but such assignment, for the purpose of equalizing the duties of each keeper as far as practicable, *is not to be construed as relieving the principal or any assistant keeper from the performance of a full and fair share of all the duties of the station.*

42. At light-stations where there are two light-house towers and lanterns with a light in each of the same order, the keepers shall be equally divided between the two lights for all purposes of cleaning the apparatus, lamps, plate-glass, and interior of lanterns, and in preparing each light for lighting in the evening; but in case there is an odd number of keepers at the station, then all the keepers will be required to attend in one of the lanterns at the same time and put it in order, and when that is finished they will all proceed to the other and get the light there ready for lighting, or the odd keeper may assist in each tower on alternate days, so that the principal and all the assistant keepers shall perform their fair share of the work of the light-station.

43. Where there are two lights, and but two keepers at a station, both keepers will, at the proper time in the evening, (half an hour before sunset,) proceed each to one of the lanterns, prepare for lighting, light the lights, and remain each in his lantern until the light is fully exhibited and burning steadily at its greatest height. The keeper whose regular watch it may be at that time will then take charge of both lights and employ his time in visiting each light as frequently as necessary during the remainder of his watch. *The unattended light for the time being must be frequently looked at from the occupied lantern.* At the expiration of a watch, the relieving keeper will in like manner take charge of and give his whole attention during his entire watch to both lights. When there are three keepers, they must, each one, keep one-

third of the time, constituting the entire night from sunset to sunrise.

44. At light-stations where there is but one light with two or more keepers, the daily routine duties of cleaning and polishing the apparatus, of cleaning and filling the lamp, of cleaning the plate-glass, lantern, watch-room, stairs, &c., must be divided between the keepers, if an even number, into two departments, and the keeper or keepers shall change from one department to the other every week, commencing on Sunday morning at the time of extinguishing the light.

a. First department.—The keeper or keepers having charge of the *first department* shall, immediately after the completion of the duties by the keeper of the morning watch, clean and polish the lens or other apparatus, clean and fill the lamp;* remove all dust with the feather brushes from the frame-work of the apparatus; fit new wicks, if required, and, if not required, trim carefully those already fitted to the burner; and see that everything connected with the apparatus and lamp is perfectly clean, and the light ready for lighting at the proper time in the evening.—(See directions for cleaning and polishing the apparatus, fitting wicks, trimming wicks, and filling lamps, II, III, IV, XI, XII, XIV.)

b. Second department.—The keeper or keepers having charge of the second department shall, immediately after the completion of the duties by the keeper of the morning watch, clean the plate-glass of the lantern inside and outside; clean all the copper and brass work of the apparatus; the utensils used in the lantern and watch room; the walls, floors, and balconies of the lantern; the revolving machinery, if any; the tower stairways, landings, doors, windows, window recesses, and passages from the lantern to the oil cellars.—(See directions for cleaning the plate-glass, metal work, floors, &c., VI, XLII.)

c. In case there should be an odd number of keepers at the light-station, after arranging the routine daily duties into two departments, the odd keeper will be assigned alternately one week to the first, and the following week to the second department, so that the work of all the keepers may be as nearly equal as possible.

45. *Cleaning the snow, ice, frost, &c., from the plate-glass.*—For the more effectual removal of snow, ice, frost, the salt from sea spray, and wet from the plate-glass of the lantern, which may have accumulated in the day; during the winter period, from October 1 to March 31, two keepers must go and remain on watch throughout the first hour, from half an hour before until half an hour after sunset; one to perform all the duties connected with the apparatus, lighting the lamp, regulating the height of the flame, the damper and ventilation; the other to move the apparatus cover, take down the lantern curtains, and return the oil carriers and other utensils to their proper places, &c. The journal of the light-station must show that these double watches are regularly kept from October 1 to March 31, and by whom on each day during that period of time. The keepers in charge of the lights, after the expiration of the double watch, are required to remove all accumulations of drift snow, sleet, ice, and frost from the outside, and to remove all moisture that accumulates on the inside of the glass of the lantern. During mild weather, if salt from salt-water spray accumulates on the outside of the lantern-glass, it should be washed off with clean fresh water before polishing it.

* When the weather is of such a low temperature as to render the oil when put into the lamps in the morning unfit for burning at the time for lighting, the lamps must not be filled until the evening, when, if necessary, the oil must be warmed before being put in the reservoir of the lamp.

46. Keepers having double as well as regular night watches, *must not be absent from their duties at the prescribed time for performing them.* In cases of allowable absences, and of those of absolute necessity, previous arrangements must be made with substitute keepers belonging to the light station for the performance of their prescribed duties.

47. *No light-keeper is or will be exempt or excused from keeping his regular watch at night, or from performing a full share of all the duties of the light-station in his charge, or to which he is attached as an assistant, except by reason of incapacity on account of sickness, or other physical or mental disability.* In the event of sickness or other disability, which prevents a keeper from performing his duties, the light must not be allowed to be neglected, but immediate report must be made to the Inspector or Engineer, who will apply the proper remedy, or ask for instructions from the Board, until a substitute or successor, by nomination of the Superintendent of Lights, can be appointed.

48. *No circumstances whatever can or will excuse any light keeper for failing to exhibit at the prescribed time the lights in his charge, or for neglecting to keep them burning as brightly and with as great power as it is possible to make them; any neglect in this regard will subject the delinquent keeper or keepers to dismissal.**

49. Light keepers will call their reliefs, at the termination of their respective watches, by the bells or speaking-tubes, when they are fitted. Where there are no bell wires or speaking-tubes leading to the watch-room, the keeper on watch will call his relief a few minutes before the expiration of his watch, *and return immediately to the lantern, where he will remain until the arrival of his relief,* when he will turn over the light to the relief, and inform him before leaving the lantern of everything in regard to the condition of the apparatus, lamp-burner, ventilators, the effect of the state of the weather on the flame, and the height the flame during his watch.

50. Keepers who are arranged in regular watches are required to remain in the lanterns and give their unremitting attention and care to the illuminating apparatus, lamp-burner, and the ventilation of the lantern during the entire periods of their charge of the light, *and regular watches must be kept at all light-stations with more than one keeper.* At stations with only one keeper the light must be visited at least twice during the night, the keeper to be called by an alarm-bell clock, set to the proper hour for visiting the light.

51. No principal or other keeper has authority or will be allowed to excuse any assistant or other keeper from keeping his regular watch in the lantern, or watch-room, or from the performance of any of the duties of light keeper, *except in cases of sickness or other cause of disability,* which, if of any considerable duration, or if it in any way seriously interferes with the regular and proper exhibition of the lights, must be reported to the Light-house Inspector immediately.

52. Keepers and assistants are not to absent themselves for any length of time from their light-stations at the same time, and especially at the time for exhibiting their lights. Temporary absences during the day, for a few hours, from stations where the keepers have families capable of protecting the public property from damage by strangers, *are not prohibited, but light-stations must never be left wholly unattended by a responsible member of the keeper's family or an assistant.*

53. Keepers and their assistants must endeavor to make such an

* See heights of flames on placard, and conform to them strictly.

equitable arrangement among themselves so that each one may have the full benefit of allowable absences, without interfering with the rights of one another, or neglecting the proper light duties.

54. No principal keeper will be justified in leaving his station without informing the assistant or assistants of his intention to do so, and of the probable duration of his absence; nor will any assistant keeper be held excusable for leaving his light-station without the previous knowledge and consent of the principal keeper; but this regulation will not justify any principal keeper in withholding from the assistant all or any reasonable privileges in regard to recreation and leaves of absence. A regular monthly report of all absences must be made to the Inspector on the prescribed form, and any abuse of the privilege must be reported by the Inspector to the Light-house Board. Any refusal or failure to report all absences, with reasons, will subject the keeper to recommendation for dismissal.

55. Keepers of all light-stations where there are no assistant keepers, and the principal keepers of light-stations having assistants, are responsible for and accountable to the Light-house Board for the faithful management of the lights; for the proper attendance upon them; for the cleanliness, care, preservation, and management of the illuminating apparatus, lamps, movable machinery, tools, utensils, and fog-signals; for the regular, proper, and economical issue and use of the oil, wicks, chimneys, cleaning materials, and all other articles of supply; for the good order and proper condition of the lantern, lantern-floors, stairways, stair-landings, windows, window-recesses, watch-rooms, oil-rooms, closets, and storerooms of the light-house towers; for the proper care and cleanliness of the interior of the keepers' dwellings of the stations; and for the proper use, preservation, condition, and care of all light-house property on or belonging to the premises in his charge. All damage done by storms, fires, or accidents, to light-house buildings and premises, must be promptly reported by letter to the Light-house Inspector of the district.

56. During the absence or disability of principal keepers to perform their duties, the senior assistant, if there be more than one, otherwise the assistant keeper, will be responsible for the requirements embraced in article 56 of these instructions.

57. In case any light keeper at a station neglects his duties, it is the imperative duty of the other keeper or keepers to report the facts without delay to the district Inspector. The reported keeper must be informed of the complaints made against him, so that he may, if he sees fit, transmit his statement to the Inspector with the report.

58. Keepers of lights without assistants, are required to take from the oil and store rooms daily the necessary articles and quantities of supplies for each day's use, and at the time of doing so to enter them correctly in the expenditure books. Keepers having assistants will, in the presence of an assistant, attend personally to the daily issue of the necessary supplies for the day's consumption. The oil must be drawn and measured in the presence of an assistant, the exact quantity noted by the principal on his slate or memorandum book then and there, and the entries copied by him without delay into the expenditure book. The air cocks of the oil butts are to be kept carefully closed when oil is not being drawn off; the oil gutters in the oil butts are to be examined frequently, and sufficient oil kept in them to exclude the air effectually from the oil through the lid; and the turning keys, after carefully closing the draw-off cocks, are to be removed and placed on the tray by the side of the oil

*measures, or hung up in a safe and convenient place. Dripping pans or buckets must be kept under the cocks of all oil butts at all times.**

59. Light keepers are required to wear the long linen aprons provided for their use while employed cleaning and polishing the lens apparatus, to prevent it from being injured by coming in contact with rough material, metal buttons, &c. Great care must be taken to prevent the glass prisms of the apparatus and the plate-glass of the lantern from being scratched by persons passing or rubbing against it.

FOG-SIGNALS.

60. These essential aids to navigation demand the same care and attention on the part of the keepers that the lights do. Whistles, sirens, trumpets, or bells, fitted with the necessary machinery, are to be rung by hand, require to be examined daily, to see that all is in working order and adjustment. The bells, fog-horns, or gongs must be kept clean at all times, and nothing permitted to be in their vicinity which will destroy or lessen their usefulness to the mariner, by deadening the sound or deflecting it from its proper direction. *During thick or foggy weather and snow storms, these signals, whether worked by machinery or otherwise, must be made at the prescribed periods of time, and with all possible regularity, to enable those within the limits of their sound to distinguish them from others in their vicinity.*—(See printed directions and instructions for managing fog-signals.)

DAY-SIGNALS AND DISTINGUISHING MARKS.

61. *No change in the color of towers, buildings, or their appendages will be allowed to be made, except by the positive written directions of the Light-house Board to the Engineer or Inspector of the district.* In all cases where tide-signals are required to be made, the keepers will be specially instructed on the subject.

62. When boats are allowed at light-stations, to enable light keepers to perform their duties more efficiently than they could perform them without their assistance, they are to be properly cared for, and any injury to them, caused by neglect, will be chargeable to the keepers. The boats, when not actually in use, are to be hauled up and properly protected, and oars, sails, rudder, &c., are to be taken to the keeper's house for safety.—(See General Order Circular.)

63. Keepers *must reside at the light-stations* in their charge or to which they are attached.

64. Keepers and assistants *are not permitted to employ substitutes* to attend upon the lights in their charge or to which they are regularly appointed.

65. Keepers are required to report, according to the prescribed form, all absences of themselves and assistants from the light-stations, setting forth day of leaving, day of returning, and the length of time absent on each occasion, with explanatory reasons for such absences. Any failure or refusal to make these reports at the end of each month will subject the keeper to the serious consequence of being reported for dismissal.

66. All official communications from light-keepers must be made to the Light-house Inspectors or Engineers of the district, who will either attend to them or report to the Light-house Board for instructions.

* See placard circular, which must be kept hung up in the *oil room* above the oil butts, where it will attract attention.

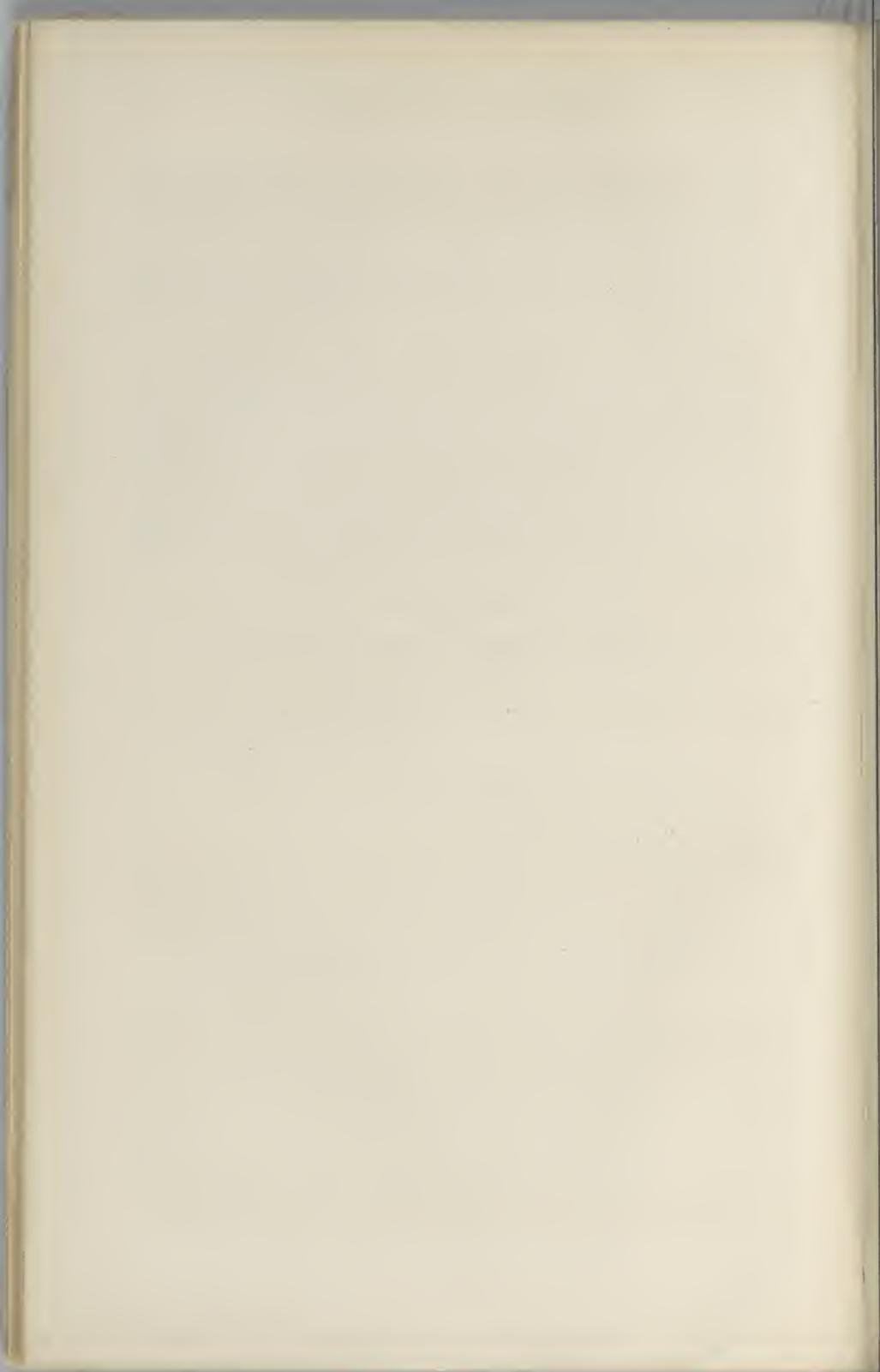
67. *These instructions are to be regarded and conformed to by all light-keepers, without reference to or prejudice of any others which may have been, or may hereafter be, issued to any particular light or station of a specific or more detailed character to render lights more useful, or in consequence of neglect of duty at any particular station.*

68. *These instructions will be supplied to all light-stations, to Light-house Engineers, Inspectors, masters of supply-vessels, tenders, and all others to whom they may apply. At all the light-stations, they are to be kept accessible to all the keepers, whose duty it will be to read them over as often as may be necessary to enable them to conform strictly, in the performance of their duties, to the prescribed requirements. Light-house Inspectors and others, making inspections of lights, are expected and required to ask such questions of the different keepers, in regard to their duties, and the instructions and directions for their guidance, as will enable them to judge of their knowledge of their duties. Those keepers who manifest indifference to the proper performance of their duties, or show ignorance of the instructions and directions, should be reported to the Board.*

69. *The directions and the extracts from the Light-house Board regulations, which follow the foregoing instructions, require to be carefully studied by all persons connected with the light-house service to whom they apply.*

LIGHT-VESSELS.

70. *The foregoing instructions will be followed by keepers of light-vessels, so far as they are applicable to them.—(See article LIV.)*



DIRECTIONS

TO

LIGHT-HOUSE KEEPERS,

SHOWING HOW TO PERFORM THEIR DUTIES IN CONFORMITY TO THE FOREGOING INSTRUCTIONS.

DAILY MORNING DUTIES.

I.—EXTINGUISHING LIGHTS, ETC.

1. Extinguish the lights punctually at sunrise.—(See VII.)
2. Hang and spread the lantern curtains immediately after the lights are extinguished.
3. Put on the long linen aprons provided for the use of keepers, to protect the illuminating apparatus from injury from contact with the ordinary wearing apparel, metal buttons, &c.
4. Commence at once the duty of putting the lamps, burners, and illuminating apparatus in order, and the whole interior and exterior of the lantern in proper condition for the proper exhibition of the light at sunset in the evening.

DAILY CLEANING OF THE GLASS OF THE LANTERN.

1. The glass of the lantern must be kept always in a state of perfect cleanliness.
2. To insure this, it will be necessary to dust it with a feather brush, and to wipe it off inside daily with a clean linen rag or towel, free from oil, and in the same manner outside, if required.
3. Any discolorations which remain upon the panes of plate-glass after this cleaning, must be removed by using a little water, and spirits of wine if necessary; and if salt spray is on it, it must be washed off with fresh water.

POLISHING THE PLATE-GLASS OF THE LANTERN.

1. Independently of these daily cleanings, the plate-glass of the lantern must be thoroughly cleaned every year with the polishing rouge, both inside and out, always observing the same precautions as are prescribed for cleaning the optical parts of the apparatus.

II.—CLEAN THE LAMPS AND BURNERS.

1. The reservoirs, tubes, and burners must be thoroughly cleaned daily. The brass work of the lamps outside must be kept clean by rubbing them with *pulverized rotten stone mixed* in a little oil, and afterwards by using whiting.

2. At least once in two weeks the reservoirs, tubes, and burners or light-house and light-vessel lamps must be thoroughly cleaned with hot lye or a strong mixture of soap and water, (soapsuds,) and until all gummy matter which may have accumulated to prevent a perfect and uniform flow of oil to the wicks in the burners has been completely removed.

III.—TRIM AND RENEW WICKS IN BURNERS.

1. Trim the wicks, leaving the burners in their places.
2. Remove the charred and carbonized parts of the wicks by using sharp trimming-scissors and trimming-hooks, taking pains to cut the tops of the wicks perfectly smooth and even.
3. Wicks which have not been cut evenly and smoothly will, when lighted, produce smoky points, a bad light, and a soiled chimney.
4. Renew wicks to burners, if necessary, by removing the burner from its place in the lamp, withdrawing the remaining portion of the old wicks and putting in new wicks with the aid of the mandril.

ATTENDANCE ON LENSES, CATADIOPTRIC RINGS, ETC.

DAILY CLEANINGS, ETC.

1. It is necessary to dust the lenses daily with a feather brush, and also the catadioptric rings of the apparatus, then wipe them off with a piece of soft clean linen, and rub them with a soft, clean, and dry chamois skin.

2. If these pieces are wiped before being dusted, their surfaces will be scratched and seriously injured.

METALLIC REFLECTORS.

1. The metallic reflectors, employed as additional pieces in some of the lens lights, and the parabolic reflectors used in light-houses and on board of light-vessels, should be rubbed daily, first with a soft linen, and then with buffskins kept solely for that purpose.

2. They must always be carefully dusted with a feather brush before being burnished, and particular care must be taken that the buff or chamois skins used in rubbing them be perfectly free from *damp, dust, and gritty particles*. Without these precautions, the attempts to polish will only tend to scratch the reflectors. The great art of keeping reflectors bright, consists in the *patient and skilful application of manual labor in rubbing their surfaces* with three different chamois skins, beginning at the centre, and gradually working outwards with a circular motion of the hand. This first chamois skin should be lightly dusted with prepared rouge powder of the purest kind, kept in a small double bag of muslin. The second and third chamois skins should have no rouge on them, and the rubbing with the third should be done in a light and quick manner. *No damp or wet substance should ever be applied to silvered reflectors.*

3. Once every two months these metallic reflectors ought to be cleaned with whiting.

4. This whiting should be prepared in the same way as the polishing rouge, and the same precautions should be observed in its use.

5. This is the more essential, as the polish of the silver plate is more susceptible to injury than glass.

IV.—FILL THE LAMP RESERVOIR.

1. In weather of moderate temperature, when there is no risk of the oil becoming stiff or too thick to flow freely to the burners if left in the reservoir in the lantern during the day, the reservoir must be filled, and the burner, properly wicked, ready for lighting, put in its place as soon as the cleaning of the apparatus is completed; but if the temperature should be so low as to render the oil during the day if kept in the lantern unfit for use at the time for lighting the lamps in the evening, the oil must not be put into the reservoir until it has been warmed, and just before the time of lighting.

2. The lamp and burner cover must be put and kept on to prevent injury to the oil and wicks while it is not in use.

3. Whenever it becomes necessary, owing to the low temperature, to warm the oil before filling the lamp reservoir, it must be carefully done in the keeper's dwelling or kitchen, and the heaters or frost lamps in readiness for use in the lantern to preserve the oil in a sufficiently fluid state for burning until sufficient heat is generated in the lantern for that purpose by the main lamp. The pumps of the lamps should be put in motion, or the oil turned on in other than mechanical lamps, at least ten minutes before lighting the wicks, to allow them to become thoroughly saturated with oil.

4. All lamps used in the light-house service will be provided with frost lamps, heaters, or other proper means for keeping the oil in a sufficiently fluid state in very cold weather for burning freely.

5. Fountain lamps used in small beacon lights and on board of light-vessels will be provided with metal heaters, to be inserted in the fountains, with a curved end and knob over the lamp chimneys, to conduct the heat to the oil. These heaters must be warmed when it becomes necessary to use them.

V.—ILLUMINATING APPARATUS AND LAMP COVERS.

1. If the lamps are in position, they must be covered while the apparatus is being polished and cleaned. The lamp and burners must be verified daily, (immediately after cleaning and filling the lamp,) to see that the centre of the burner is in the vertical axis of the lens, and that the crown (top) of the burner is perfectly level and at the prescribed distance below the focal plane.

2. The *lenses and prisms* of the illuminating apparatus *must be cleaned daily*, by being *first freed from all dust* by a clean feather brush, and then carefully rubbed all over with a clean, soft chamois or buffskin. If any parts of the lenses or prisms have become greasy or soiled in any way, the parts thus soiled must be rubbed with a clean soft linen rag or towel, *after it has been steeped in spirits of wine*, and then wiped perfectly dry with a clean dry linen towel; and lastly, it must be rubbed, until a perfect polish is restored, with a clean, dry, chamois or buffskin.

3. In all cases after cleaning, the illuminating apparatus should be fixed *dead* to some permanent fixture in the light room or lantern, so that the axis of the beam of light will always point in the desired direction.

4. It may sometimes become necessary to use a little *fine, carefully-prepared rouge powder* on a chamois skin to restore the polish to a badly-

stained spot, but with proper care and management on the part of the keepers this will seldom, if ever, happen to the apparatus.

The lens apparatus must then be carefully and properly covered with the cover provided for the apparatus.

TO REMOVE OIL SPOTS FROM THE GLASS.

1. If oil should get on any part of the surfaces of the lenses or catadioptric rings, it ought to be cleaned off immediately with a piece of linen wet with spirits of wine, and then carefully dried with a clean soft linen rubber or towel, and finally rub with a soft clean chamois skin.

2. Once in every two months the entire surfaces of the lenses and the mirrors must be washed with spirits of wine; after which washing, each piece must be carefully wiped in the manner directed.

3. These same pieces ought to be polished with rouge once a year, and oftener if found to be necessary.

4. That operation should be executed as follows: Break up a small quantity of rouge (say $\frac{1}{2}$ ounce) in water, and form a clear mixture with it. Put this mixture into about a pint of water, and, after having stirred it up well with a stick, let it rest for a few moments. Then pour off the liquid mixture into another vessel carefully, to separate the small, gritty particles which it may contain, and which, by this means, will remain at the bottom of the first vessel. That being done, leave it to settle about half an hour, when pour off the water until the rouge appears on the edge of the vessel.

5. This liquid rouge must be spread lightly, by means of a camel's hair brush or piece of soft linen, over the entire surface of the glass to be cleaned.

6. When this coat of rouge becomes dry, rub it with a piece of buff-skin until all of it is entirely removed.

7. The rouge, thus prepared, should be entirely consumed, as it will be unfit for future use in cleaning.

8. Spots or stains on the lens apparatus or plate-glass, which cannot be removed by the use of rouge, whiting, and spirits of wine, may be removed by using *oxalic or muriatic acid in a very dilute state*.

VI.—CLEANING TOWERS AND LANTERNS.

1. All illuminating apparatus and lamps, and all oil, cleaning materials and utensils of all descriptions, must be carefully covered before cleaning of any kind is commenced in the lanterns, and every precaution must be taken to exclude soot, dust, sand, water, &c., from them at all times.

2. Light-keepers are strictly prohibited from cleaning the floors of the lanterns, and the stairs and the floors of the towers, with dry sand, dry lime, or any other dry material by which dust is produced, and also from sanding the floors, stairs, passages, &c., of the towers.

3. All cleaning of lanterns, floors, stairs, passages, &c., of towers must be done with wet or damp materials, which must be carefully moved before they become dry.

4. Sweeping in the towers and lanterns must be done with care, and chiefly with hand hair brushes.

5. When oil is spilt on the stairs or floor of the towers, it must be carefully wiped up with a cloth and the spot covered with a coating of thick new whitewash, to be renewed, as soon as it gets dry, until the oil is removed, when the lime must be washed off.

VII.—MANNER OF EXTINGUISHING LAMPS.

1. The principal duties to be performed in the morning must be executed in the following order:

2. At sunrise extinguish the lamps of the apparatus by lowering the wicks, commencing with the outer wick, and proceed gradually, to avoid breaking the chimney by a too rapid change of temperature and contraction of the glass. The chimney, when removed hot from the burner, must be carefully wrapped in the flannel cloth, provided for that purpose, and laid in the chimney basket or box.

VIII.—RAISING THE CLOCK WEIGHT.

1. Wind up the clock weight of the lamp level with the service table, *and relieve the cord from the strain of the weight, by supporting the weight by an iron bar provided for the purpose.*

IX.—RAISING THE WEIGHT OF THE REVOLVING MACHINERY.

1. If it is a revolving light, raise the weight of the machinery, *and stop the driving wheel by means of its clutch. Throw the wheels out of gear to prevent accidents, and relieve the cord from the strain of the weight, as in the case of the lamp.*

2. Hang up and arrange the curtains of the lantern, which precaution is necessary to prevent the sun's rays from melting the burner of the lamp.

3. Remove the glass chimney, and if not hot place it temporarily on the servicetable; otherwise, wrap it in the flannel cloth and lay it in its basket or box.

4. Trim the wicks of the lamp exactly even with the burner, as before directed in the article III.

5. Clean the interior of the burner with a small flexible bottle or phial brush and all of the exterior of the lamp with a cloth, or other prescribed means.

X.—TO CLEAN THE RESERVOIR AND RENEW THE OIL.

1. Pour out the oil from the reservoir into a vessel, which must be set aside. Having allowed this oil to settle for a few hours, it should be poured into a filter with some fresh oil. This filtering is indispensable, even for new oil, to remove from it the small particles of cotton which it nearly always contains.*

2. The reservoir should be rinsed out with newly filtered oil, (which should afterwards be again filtered;*) and with a clean piece of linen

* Lard oil which has not passed through the lamp burner need not be filtered if of good quality and clear, but all other oils (colza and sperm) require to be filtered for use in mechanical lamps always before being used, and lard oil which has passed through a lamp must be filtered for further use.

attached to a small stick remove all the dirt which may have remained after the rinsing.

3. If the filter of the feed tube be obstructed, it should be removed and cleaned, and then replaced.

4. The reservoir should then be filled with oil freshly filtered.*

XI.—CLEANING THE GLASS CHIMNEYS.

1. The glass chimneys soiled by smoke, or by drops of burnt oil, must be cleaned by rubbing them with a rag or small piece of soft wood dipped in oil, until all the stains disappear; after which, wipe them off, and clean them with whiting.

2. Chimneys will, in this way, be restored to perfect cleanliness and transparency.

3. If this does not remove the discoloration, they should be rubbed with a wet cloth and a little soda or common salt, but great care must be taken to wash them with warm water afterwards, as any salt adhering will cause breakage.

4. They must then be deposited in one of the cases, or in the closet of the lantern room.

XII.—RENEWING THE WICKS.

1. Whenever a part, or all of the wicks of the burner of the mechanical lamp in use are renewed, it will be necessary immediately to work the pumps for one hour, so as to soak them well with oil; but, with hydraulic lamps, the oil will force itself through the burner, and soon completely saturate the wicks.

2. To fit a wick, if a single wick burner, in its place, raise the wick-holder to its greatest height; remove it, and introduce the tin or wooden mandril designed to receive the wick; then shove down the wick to the bottom of the wick-holder, and secure it there by means of a tin ring supplied for that purpose.

3. Should the ring be missing, its place must be supplied by a thread.

4. It is very important that the edge of the wick should be cut very regular, and covered so that no projection which will interfere with the passage of the oil may be left.

5. The wick being placed, lower it to its lowest point, and cut the upper edge even with the top of the burner, in the neatest and most regular manner possible, with the sharp curved scissors.

XIII.—MULTIPLE WICK LAMPS.

1. In preparing a mechanical or other multiple wick lamp for lighting, it is necessary to conform to the following directions:

TO PUT ON THE WICKS.

a. The multiple burner is first supplied with wicks; and for each of them proceed as follows:

b. The wick-holder, detached from the burner, is placed upon that part of the mandril designed to receive it.

* Lard oil which has not passed through the lamp burner need not be filtered if of good quality and clear, but all other oils (colza and sperm) require to be filtered for use in mechanical lamps always before being used, and lard oil which has passed through a lamp, must be filtered for further use.

c. The wick is first put over this mandril, and then slid to the bottom of the wick-holder, where it is firmly fixed by a tin ring; the lower edge being cut evenly, and regularly covered by the ring, so as not to impede the passage of the oil.

d. If any of the wicks are found to be of too great diameter, they can be reduced to the proper dimensions by removing carefully a sufficient number of the threads of the chain.

WIDTHS OF THE DIFFERENT ORDERS AND NUMBERS OF WICKS WHEN PRESSED FLAT.

- a. For a first order burner, wick No. 1, 1.34 inch.
- “ “ “ “ “ No. 2, 2.56 inches.
- “ “ “ “ “ No. 3, 3.82 inches.
- “ “ “ “ “ No. 4, 5.19 inches.
- b. For a second order burner, wick No. 1, 1.4 inch.
- “ “ “ “ “ No. 2, 2.79 inches.
- “ “ “ “ “ No. 3, 4.17 inches.
- c. For a third order burner, (large size,) wick No. 1, 1.18 inch.
- “ “ “ “ “ No. 2, 2.40 inches.
- d. For a third order burner, (small size,) wick No. 1, 0.97 inch.
- “ “ “ “ “ No. 2, 1.95 inch
- e. For a fourth order single wick burner, wick, 1.75 inch.
- f. For a fifth order “ “ “ “ 1.50 “
- g. For a sixth order “ “ “ “ 1.30 “
- h. For a steamer's lens (small size) wick 1.18 inch.
- i. For 21-inch parabolic reflector burner, wick, 1.50 inch.
- j. For 12-inch parabolic reflector burner, wick 1.30 “

XIV.—TO TRIM THE EDGES OF THE WICKS.

1. The wicks being put on, they are lowered to the lowest point; then, with very sharp curved scissors their upper edges are cut close to the burner.

2. If the crown of the burner should present any points or projecting threads, these inequalities would cause the flame to smoke, and the burner would soon be covered with collections of carbonized wick, like mushrooms.

3. *It is, therefore, very essential that the wicks should be evenly trimmed, as well in this first operation as in all successive trimmings or snuffings.*

4. When the chimney is replaced, the wick must be raised very gradually until the flame becomes of the proper height to prevent the coal-ing of the wick and the too rapid heating of the chimney; and proper attention to the ventilation of the lantern, will, in general, insure the proper burning of the lamp during the night.

XV.—COVERING THE SERVICE LAMP.

1. After having completed the morning duties, so far as the lamp is concerned, including the verification of its position in the vertical axis of the lens, and the top below the focal flame the prescribed distance, (see XXXV,) it should have its cover placed over it, so as to protect the burner, the pumps, and the reservoir from dust, until the time for lighting.

EVENING AND NIGHT SERVICE.

XVI.—ORDER OF EVENING DUTIES.

1. The night service of the large orders of lens lights is performed by two or three keepers, divided into successive watches of four hours' duration, and that of the smaller orders of lenses by one or two keepers, according to circumstances.

2. Every evening, half an hour before sunset, the keepers, provided with a lighting lamp, (lucerne,*) will ascend to the lantern of the tower, if the daily routine has been regularly and faithfully performed, the following will be the condition of things:

a. The lamp of the apparatus, ready for lighting, will be capped with its cover.

b. The clock weight, raised to its greatest height, will be held by an iron rod on a level with the service table.

c. The glass chimney, deposited in a small box or basket, will be placed on the service table, and also the tool-basket containing the ordinary implements of the lighting service.

d. Four glass chimneys and a spare burner fitted with dry wicks must be in reserve in one of the cases of the table of the frame, or in the small closet of the lantern room.

e. In one of the closets of the lantern room must be found the two spare lamps, capped with their covers and fitted with their cords. The one of the two lamps, (which in case of necessity is to be placed in the apparatus,) must, in addition, be fitted with its movable pulley.

f. A vessel filled with filtered oil must be in the lantern room.

g. If there is a revolving machine, the weight will be raised to its greatest height and will be supported by an iron rod; the driving wheel will be held by its clutch, and the bevel wheels will be unengaged.

h. To prevent the failure of a light in the light-house, a taper (lucerne) must be kept lighted in the lantern room, and near by a rod lamp placed ready to be lighted in case it should become necessary to trim or change the service lamp.

i. The curtains of the lantern will be properly spread and hung, and the pieces of the optical parts of the apparatus will be covered with the covers provided to protect them from the action of the sun.

XVII.—TO LIGHT THE LAMP.

a. Everything being in readiness and in order, as presented in XVI, commence lighting the lamp at sunset, so that the light may have its full effect by the time twilight ends.

b. In executing that duty, and in managing the lamp, the following directions must be followed:

c. To light a lamp, commence by raising the wick about one-third of an inch above the top of the burner, and light it at two opposite points, *using for that purpose the small hand-lamp (lucerne) specially designed for lighting, and nothing else.*

d. As soon as the flame commences to rise all around, and before it begins to smoke, lower the wick, and place the chimney in its holder.

* Matches, paper lighters, or other means than the small lighting lamps, (lucernes,) must not be employed in lighting lamps.

At first, *keep the wick low and the chimney high*; afterwards raise the wick to its proper height, and lower the chimney to its position, in succession, using the damper in the tube by the key until a clear white flame is obtained of such height as the description of lamp requires. The wicks must be raised very gradually during the first twenty minutes or half hour after commencing to light them.

e. To light lamps with two or more concentric wicks, commence with the inner one, which should be lowered as much as possible (without risk of extinguishing the light) as soon as it has caught all around; follow the same course with the next wick; having lighted all the wicks in regular order as prescribed for the inner one, commence raising them gradually and lower the chimney at the same time.

f. The flame of a burner of two or more concentric wicks requires about half an hour to reach its full development.

g. Multiple burner wicks must be well saturated with oil, and the proper flow regulated before they are lighted, when the following precautions should be observed: *The central, or No. 1 wick, should be raised about $\frac{3}{16}$ of an inch, and then with the lucerne (lighting lamp) light it at the four opposite points; immediately after which lower it to the lowest point at which it will burn.* Proceed in the same manner with the outer wicks, Nos. 2, 3, and 4, hastening, in each instance, to lower the lighted wick to prevent smoking the apparatus, and too rapidly charring the wick.

h. Having lighted all the wicks and lowered them as directed, place the glass chimney on the burner and put on the damper tube, and then raise the wicks, one after another, very gradually, using the chimney and damper for obtaining the best and highest possible flame. (See plates showing fully developed flames and their heights, Article XXVI.) Special care must be taken to verify the flow of oil through the burner by noting the time it requires to fill the 250 grammes measure provided for that purpose. (XCII.)

i. If the flame cannot be kept steadily at the prescribed height, the keeper must lose no time, and spare no efforts, in endeavoring to ascertain the cause, whether or not it is due to a want of cleanliness of the burner, proper flow of oil, imperfection of wicks, bad oil, or to the draught and ventilation of the lantern, and remedy the defects at once.

j. The management of the flame, so that it will constantly burn bright, clear, and high, is the most important part of a keeper's duty, and requires constant attention and great care, even with the best constructed and kept apparatus and lamps. In that way *only* can the maximum quantity of oil be consumed, and the best light produced.

XVIII.—TO PUT THE REVOLVING MACHINERY IN MOTION.

1. If it is a revolving light, put the revolving machinery in motion immediately after lighting up.

2. To do this it is sufficient to lower the pivot of the connecting wheels, so that the bevel wheels gear properly, and then remove the support of the weight and the clutch of the driving wheel.

XIX.—VENTILATION.

1. One of the most important duties of the light-keeper is to be watchful and attentive in keeping the lantern well ventilated.

2. When there is very little wind, a portion of all the ventilators placed in the lower part of the lantern may be opened, having due regard to the clear and steady burning of the light.

3. When there is much wind, the leeward ventilators alone must be opened, and only so much of them as is necessary to allow the lights to burn bright, steady, and clear.

4. Irregular currents of air, produced either by the trap or balcony door, or by the windward ventilators, are injurious to the light, though the means employed may be in other respects good.

5. Before leaving the lantern, even for a moment, the keeper must be certain that the ventilators are sufficiently open to admit the necessary quantity of air to produce good combustion, and prevent condensation or sweating on the lantern glass.

6. Proper ventilation of the lantern, proper management of the damper, and the proper position of the lamp chimney, with reference to the height of the flame as it increases in height after being lighted, and to meet the changes of the atmosphere, only will insure a good, bright, and steady light for any considerable length of time, hence the great importance of giving the greatest possible attention to these three special duties, at all times during the exhibition of a light.

XX.—TO TRIM THE WICKS OF THE LAMP AT NIGHT.

1. If, after a long combustion, the wicks are found to be too much carbonized to allow their flames to be kept at a proper height, by closing the damper one-half, and also raising the wicks about one-tenth of an inch higher, they may be trimmed, or the charred wicks removed by using the trimming hooks through the burners.

2. Or the lamp must be removed for trimming.

3. In this operation, the following precautions should be observed :

a. Suspend in the middle of the apparatus the rod lamp kept in the lantern room for this purpose, and place the lighting lamp on the service table with two spare, clean, and dry glass chimneys.

b. Extinguish the service lamps by lowering the wicks; take down the damper tube if it is not fixed to the apparatus, and then remove the chimney with the chimney-lifter, covered with chamois leather or by applying a piece of very dry cloth around it, which will allow it to be handled without inconvenience from its heat; wrap it up in the flannel cloth provided for that purpose, and place it in its box, where it will cool gradually without breaking.

c. Stop the machinery by winding up the motive weight and placing it on a level with the frame, resting it on its support; then trim the wicks as rapidly as possible; after which, remove the support of the weight and relight the wicks, raising them at once to the height of about one-fourth of an inch. Having completed this operation, replace the chimney, (which is still warm,) and in a few minutes the flames, with proper care and attention to the wicks, will reach their original height. Should the service chimney break, it must be replaced by one of the two spare chimneys. In this case it will be necessary to keep the flames down for some moments, so as not to heat the new chimney too rapidly.

d. It may be necessary to trim the wicks again if carbonized particles form on them and produce a red and smoky flame. These collections of carbonized particles are ordinarily occasioned by the points or threads left on the edges of the wicks, or by the dust or dirt which

may adhere to them, which obstruct some part of the openings intended to preserve a proper circulation of the air, or by the bad quality of the oil used. This may be remedied sometimes by using the trimming hooks inside the burners and sharp prickers for removing the "thieves" or "mushrooms" which form on the wicks, without regular trimming.

e. In case smoky points appear after lighting the lamps in the evening, or at night after trimming the wicks, they must be very carefully cut off, which may be done ordinarily without wholly extinguishing the light, and removing the burner from the lamp if a fixed light.

4. A lamp that has been properly wicked, the wicks smoothly and evenly trimmed on top, and gradually raised after being lighted all around until the flame reaches its greatest attainable height, free from smoke and smoky points, will, with proper ventilation, burn many hours steadily and brightly without the necessity for trimming the wicks.

5. Mechanical and other *overflow* lamps being constructed to pass through their burners *at least four times* the quantity of oil actually consumed during the period of burning, the wicks char (*when properly attended at first lighting*) very slowly, and those lamps burn well, ordinarily, (without being trimmed,) from fifteen to sixteen hours. One of the tests of oil is, that it shall burn in a fifth-order Franklin lamp, with undiminished flame, *for twelve consecutive hours without trimming*, and it frequently burns from seventeen to nineteen hours. When, however, the flame, from any cause, begins to sink, and cannot be brought up to its normal height, the wicks must be trimmed, or the charred wick removed by passing the trimming hooks up through the air spaces of the burners and knocking off and picking out the charred particles piecemeal.

6. Argand fountain lamps, properly lighted *at first*, may require to be trimmed *once during long nights*. A gradual sinking of the flame is the indication, and it must not be disregarded.

7. The spare lamp (or a rod lamp previously lighted and burning well) must take the place of the lamp if it is to be removed for trimming the wicks at night. Always at night a spare lamp filled and a spare burner trimmed and ready for lighting must be kept in the watch-room, with coupling plyers attached, so that the lamp may be put into instant use if the other should become deranged in any way. The rod lamp must be ready also.

XXI.—TO CHANGE THE SERVICE LAMP.

1. When, in the course of the night, any accident happens to the lamp rendering necessary the immediate substitution of a spare one, the following directions must be observed:

a. Bring the spare lamp which has been previously prepared as directed, and place it on the service table.

b. Hang in the centre of the apparatus the rod lamp designed and kept for that purpose in the lantern room.

c. Deposit on the stand, or on the gallery, two glass chimneys, the tool basket, the lighting lamp, and the spare burner fitted with its wicks, if the service burner is to be removed.

d. After having *gradually lowered the wicks* of the lamp of the apparatus for extinguishing them, *remove the chimney*, observing the precautions indicated above; *wind up the weight to its greatest height*, (if a mechanical lamp,) and *suspend it at the level of the service table by its*

clutch; unhook the pulley, and then remove the lamp from the apparatus and replace it by the spare one.

e. That being done, adjust upon it the old burner, (if it will answer,) or the new one if it be necessary, after having plunged it into the oil to saturate the new wicks, and proceed as rapidly as possible to verify the position of the crown of the burner. (XXXV.)

f. If the crown of the burner is found not to be level, it must be made approximately so by the use of the screws and spirit levels.

g. Then pour the oil from the oil vessel into the cistern of the new lamp.

2. The spare lamp having been thus placed with the greatest rapidity, it must be put in motion and lighted with the greatest celerity compatible with the precautions necessary to prevent the chimney from being broken.

3. When the light is extinguished next morning, proceed at once to rectify the placing of the lamp with care. (XXXV.)

4. When there is more than one keeper, the one on watch must call assistance before commencing the exchange of a lamp, and all keepers must remain in the lantern and assist until the light is fairly burning.

XXII.—GLASS CHIMNEY.

1. The *glass chimney* is supported by a cylindrical gallery, which is elevated or lowered according as it is turned to the left or to the right.

2. Upon the summit of the chimney is placed a sheet-iron or copper tube, in the interior of which is fitted a *register* or *dampener*, which serves to regulate at will the opening of the tube, and regulates the draught.

3. In some light-houses this tube is sustained by an iron collar fixed to the apparatus, uniting with another above leading into the cowl, and the glass chimney fitting easily into the lower part, and to the height of an inch or two, and in others it supplies the space from an inch or two below the top of the chimney when in place, and the lower end of the part leading into the cowl.

4. The *glass chimney* must be entirely free from dust, soot, smoke, oil, dampness, and dinginess, when fitted in its holder after the lamp is lighted. Whenever it becomes necessary to remove it from a lighted lamp, it must be done by the lifter covered with chamois leather, and then carefully wrapped in a flannel cloth and placed in its box or basket to cool gradually, to prevent its breaking by a too sudden cooling and contraction.

5. While the flame is gradually attaining its greatest height, after lighting the lamp or trimming the wicks, the chimney must be properly adjusted to suit all the circumstances, otherwise the flame will smoke for want of proper draught.

XXIII.—REGULATOR AND DAMPER.

1. During the first moments of the lighting, the key of the damper should be held at an angle of 45° , and the shoulder of the glass chimney raised to its greatest height, so as to prevent its being broken by a too sudden heating. Then lower the chimney gradually to the point which will permit the flame to reach the height prescribed, which will give it its greatest effect.

2. *If the chimney be too low, it will prevent the flame from reaching the desired effect; if too high, it will produce a red and dull flame, and, after a time, smoke.*

XXIV.—MANAGEMENT OF THE REGULATOR AND DAMPER.

1. As the combustion becomes more active, the damper should be opened as much as necessary, and the wicks elevated to three-tenths of an inch, which it will be rarely proper to exceed.

2. *As the damper is opened, the flame falls and whitens; as it is closed, the flame rises, reddens, and grows smoky.*

XXV.—MANAGEMENT OF THE LAMP DURING THE FIRST HOUR AFTER LIGHTING.

1. During the first hour of combustion the height of the wicks above the burner ought not to exceed *one-fifth of an inch, and care should be taken that the flames do not rise too rapidly*, otherwise the chimney will be broken, and the wicks crusted.

XXVI.—MEAN HEIGHT OF FLAME IN FULL EFFECT.

1. At the expiration of an hour, the flames thus managed *ought to be at their full power*, and to have attained their *proper height of not less than as follows*:

a. For a lamp of the first order, from $3\frac{1}{2}$ to $3\frac{3}{4}$ inches.

b. For a lamp of the second order, from 3 to $3\frac{1}{4}$ inches.

c. For a lamp of the third order, (large,) from $2\frac{1}{2}$ to $2\frac{3}{4}$ inches.

d. For a lamp of the third order, (small,) about $2\frac{1}{2}$ inches.

e. For a lamp of the fourth order, from $1\frac{3}{4}$ to $1\frac{7}{8}$ inch.

f. For a lamp of the fifth order, from $1\frac{1}{2}$ to $1\frac{3}{4}$ inch.

g. For a lamp of the sixth order, from $1\frac{1}{2}$ to $1\frac{3}{4}$ inch.

h. The height of flames of ordinary Argand fountain lamps of beacons and light-vessels, corresponding to the full effect of those lamps, is from $1\frac{1}{2}$ to $1\frac{5}{8}$ inch, when properly attended.*

2. The height of the full power of a lamp is obtained by elevating to a proper point the movable gallery which holds the chimney, and by the proper management of the damper and ventilators. If that point is exceeded, *the flame may grow larger, but it will be dull and red; if the error is in the contrary direction, the flame will continue to be white, but without attaining such a height as is desired.*

9. The flames are to be *maintained at the proper height by the proper use of the damper key after raising the chimney in the holder.*

10. The management of flames of light-house lamps, so that they will burn continuously bright, clear, and high, and at the same time consume the maximum quantity of oil which will ensure such flames, is one of the most important parts of light keeper's duties, and requires experience and great care and attention on their part, even when provided with the best illuminating apparatus and lamps. Inspecting officers will not omit in their visits to light stations, to impress upon all keepers the great importance and necessity for such care and attention to the lights in their charge.

XXVII.—THE BURNERS.

1. The *burners of the lamps* are fitted with a single wick, or with two,

* See placard showing full heights of the flames of the different orders of lamps.

three, or four *concentric wicks*, according as they belong to the sixth, fifth, fourth, third, second, or first order, viz:

- a. For a *first order lens*, of 1.84 meter = 72.442 inches interior diameter:
- A *four wick burner*, No. 1, (inner,) 0.87 inch diameter.
 - “ “ “ No. 2, “ 1.7 inch diameter.
 - “ “ “ No. 3, “ 2.52 inches diameter.
 - “ “ “ No. 4, (outer,) 3.35 inches diameter.
- b. For a *second order lens*, 1.4 meter = 55.119 inches interior diameter:
- A *three wick burner*, No. 1, (inner,) 0.94 inch diameter.
 - “ “ “ No. 2, “ 1.8 inch diameter.
 - “ “ “ No. 3, (outer,) 1.7 inches diameter.
- c. For a *third order lens* (large size) of 1 meter = 39.371 inches interior diameter:
- A *double wick burner*, No. 1, (inner,) 0.75 inch diameter.
 - “ “ “ No. 2, (outer,) 1.54 inch diameter.
- d. For a *third order lens* (smaller size) of 0.75 meter = 29.528 inches interior diameter:
- A *double wick burner*, No. 1, (inner,) 0.63 inch diameter.
 - “ “ “ No. 2, (outer,) 1.26 inch diameter.
- e. For a *third order lens* of 0.7 meter = 27.559 inches interior diameter:
- A *double wick burner*, No. 1, (inner,) 0.63 inch diameter.
 - “ “ “ No. 2, (outer,) 1.26 inch diameter.
- f. For a *fourth order lens* of 0.5 meter = 19.685 inches interior diameter:
- A *single wick burner*, 1.25 inch diameter.
- f¹. For a *fourth order double wick burner*, (if employed,) the same as e, No 1, 0.63 inch diameter.
- No. 2, 1.26 inch diameter.
- g. For a *fifth order lens* of 0.375 meter = 14.764 inches interior diameter:
- A *single wick burner*, 0.95 inch diameter.
- h. For a *sixth order lens* of 0.30 meter = 11.811 inches interior diameter:
- A *single wick burner* of 0.83 inch diameter.
- i. For a *steamer's lens* (large) of 0.30 meter = 11.811 inches interior diameter:
- A *single wick burner* of 0.83 inch diameter.
- j. For a *steamer's lens* (small) of 0.20 meter = 7.874 inches interior diameter:
- A *single wick burner* of 0.75 inch diameter.
- k. For an *Argand fountain lamp*, attached to a 21-inch parabolic reflector:
- A *single wick burner*, 1 inch diameter.
- l. For an *Argand fountain lamp*, attached to a 12-inch parabolic reflector:
- A *single wick burner* of 0.875 inch diameter.
2. The lower part of each of the wicks is fixed by a ring upon a circular support, which is elevated or lowered by means of a small hand-screw.
 3. The oil reaches the wicks through a tube, which forms the stem of the burner, either by pumps or hydraulic pressure.
 4. *Gas burners* (when gas is used) *must be frequently renewed*, to prevent an unnecessary consumption or waste of gas, without improving

the power or brilliancy of the light. There should be a *tap* at the bottom of the gas pipe for letting off the condensed water, which should be frequently done, especially in cold weather, to prevent its freezing and bursting the pipe.

XXVIII.—REVOLVING MACHINERY.

1. In *revolving* and *flashing* lights, the movable part of the illuminating apparatus is put in motion by revolving *machine*, which has a simple fly or governor to regulate its speed.

REVOLVING MACHINERY AND ITS ACCESSORIES.

XXIX.—ATTENDANCE AND MANAGEMENT.

1. The revolving machinery requires the especial care and attention of the light keepers. Every part of it must be carefully cleaned with small brushes, furnished for the purpose, and with pieces of soft white pine, cut to the proper size and shape, to remove the dust and gummy oil which are liable to adhere to its different parts. When it is thoroughly cleaned, the pivots must be oiled, either with Porpoise jaw oil, clockwork oil, neat's foot oil, or the best quality of sperm oil; and if the fly is driven by an endless screw, that screw must be oiled also. *This operation must be performed at stated periods, and whenever, upon examination, it is found necessary.*

2. Every effort must be made to prevent, as far as possible, the introduction of dust into the interior of the case of the movable machinery of a revolving light, and the wheel-work and pivots of the machinery must be cleaned as often as necessary *with a small feather and soft clean linen.* *To perform this cleaning, the case surrounding the machinery must be removed.*

3. A small quantity of clockmakers' oil should be applied, from time to time, to the pivots of the fly, to the joints of the movable wings, (if it is acted on by a governor,) and also to the pivots of the barrel upon which the cord of the motive weight is wound. The pivots of the other pieces should be oiled also, *but less frequently.* Before applying any new oil, it will be necessary *always to see that the thick oil has been first carefully removed.*

4. *To prevent the oxidation of the polished iron and steel pieces, they must be rubbed, as often as may be found to be necessary, with a piece of cloth covered over with tallow, or some other description of unsalted grease.* Care must be taken not to spread that grease upon any of the pieces of copper, bronze, or brass.

5. If, at any time, it is observed that *the revolving machine does not go well,* and there is no very obvious cause for it, it will generally be found upon examination, that *the end of the fly shaft, or its footstep is "cutting."* The footsteps are easily shifted, and the fly shaft may generally be smoothed on an oil stone, (with which keepers of revolving lights are provided;) but if it be found to be much injured, the spare one should be put in, and the worn or damaged one sent to the lamp shop for repair.

6. The *fly*, or *governor*, must be adjusted by testing the machinery in motion with the aid of a good "time marker" of seconds, or a time-piece having a seconds' hand. The duration of the revolutions *must*

be strictly in conformity to the stated periods in the light-house list, and to directions from the proper officers of the Board.

7. The time occupied in performing the entire revolutions or the intervals between the flashes must be frequently tested by a correct clock, "time marker," or watch, and, in case of any deviation from that prescribed, the *fly* must be readjusted until the times of revolution or intervals of flashes are found to be correct. When the revolving machinery has just been thoroughly cleaned, the same weights and arrangement of fly or governor will give it more rapid motion than after it has been running for some time, and the time of revolution will continue to increase in duration until again cleaned; hence, the necessity for frequent verifications, changing of the governor or fly, and the weights.

8. All revolving light stations will be provided with a "time marker," (of some description,) beating seconds; but any time piece (the light-house establishment clock) marking time to minutes will answer for verifying the revolutions of the apparatus by taking a number of entire revolutions which will answer to a certain exact number of minutes, and in case the timepiece should be placed where one person cannot see the apparatus so as to count the revolutions and the timepiece at the sametime, two persons may readily make comparison by calling out the minutes of starting and the end of the number of revolutions answering to the required number of minutes.

XXX.—VERIFICATION OF THE MOVEMENT OF THE REVOLVING MACHINERY.

1. After having restored all the pieces of the revolving machine to their proper places, it must be put in operation, to see if it performs properly with the ordinary weights, and that each revolution of the apparatus is made in the prescribed interval of time.—(XXIX.)

2. In case the revolution should be either too slow or too fast, it may be properly modified by closing or straightening out the wings of the fly.

3. If the regulator is a governor, the movement may be increased at pleasure by raising the movable balls, or diminished by lowering them upon their stems.

4. The greater or less distance of these balls will indicate the resistance which the movable frame will oppose to the action of the machine.

XXXI.—PRESERVATION OF THE SPARE FLY.

1. *The spare fly must be enclosed in a box and placed where dampness cannot reach it.*

2. *It must be examined, from time to time, taking care to grease the polished steel pieces, and observing at each time to wipe them off beforehand.*

XXXII.—TO CLEAN THE CIRCULAR CARRIAGE OF THE MOVABLE MACHINERY.

1. *The large and small rollers of the carriage, the rollers of the revolving part, as well as the road on which they run, must be wiped off daily; the pivots of the rollers must be cleaned and oiled as often as may be found necessary.*

XXXIII.—TO DISMOUNT THE CIRCULAR CARRIAGE.

1. Whenever it becomes necessary to dismount the circular carriage of the movable frame, for the purpose of cleaning it, *commence by raising the frame a little by means of three small jacks specially provided for that purpose*, and which must be replaced in succession by square ledges of wood.

2. That being done, *raise the exterior rollers, withdraw the forelocks of the iron circle of the carriage, and then take the two pieces apart immediately, observing not to bend the journals.*

3. This duty, as well as the remounting of the carriage, will require the united services of two persons.

4. The three jacks, designed to raise the movable frame, must be kept always in good condition, and ready for use, as well as the other tools and implements.

5. All the tools and implements, *of steel or iron*, which are only required occasionally, must be kept always greased with tallow, in a dry closet.

XXXIV.—DISMOUNTING AND CLEANING THE REVOLVING MACHINERY.

1. *Once a year, (in the month of July,)* and oftener if found to be necessary, the revolving machinery must be taken down and thoroughly cleaned by the keeper.

2. To perform this duty, proceed as indicated for the mechanical lamps.

DAILY.

1. *Every morning* the cage, the driving-wheel, and the wheel of the carriage must be dusted.

2. The large vertical rollers and the small horizontal rollers, as well as the railway on which they run, must be wiped off.

WEEKLY.

1. *Every eight days these rollers must be removed*, their axles wiped, a small stick covered with linen passed through the openings which receive them, and a very small quantity of clockmakers' oil poured into them before they are replaced.

2. *Care must be taken not to remove more than one roller at a time.*

3. Occasionally, the pivots of the machinery must be lubricated with clockmakers' oil.

ANNUALLY.

1. Yearly, in July, and oftener if found to be necessary, the revolving machinery must be taken apart by the keeper and thoroughly cleaned.

a. To clean the brass parts of the machinery, *their surfaces are coated with rouge mixed in spirits of wine*, and they are then rubbed with a small soft brush until they receive a fine polish.

b. Should it be found *impracticable to remove any stains with the brush*, a small piece of soft wood and rouge must be used for the purpose.

c. The iron and steel parts must be rubbed with a piece of soft wood dipped in oil.

d. A stick covered with a piece of linen may be used to clean the holes of the pivots of the axles as well as the screw-holes.

e. Before putting the machinery together again, a small quantity of clockmakers' oil must be poured into the holes in which the axles work, and all the different parts, iron and steel, coated with tallow.

XXXV.—TO PLACE THE SERVICE LAMP.

1. The *service lamp* of a lens light is generally supported on a tripod having three vertical screw stems, fitted with nuts and washers. These stems fit in the feet of the lamp, and the adjustment is made by the nuts, and gives sufficient play to allow the *centering to be made at pleasure after the lamp is at the proper height.*

2. For the lamp to be properly placed, it is requisite—

a. That the centre of the burner correspond exactly with the vertical axis of the lens apparatus.

b. That the crown of the burner be placed immediately below the centre of the lens, at a distance determined by the height of a gauge furnished for the purpose, or by measurement with a scale properly graduated to inches and tenths of an inch.

3. This vertical distance is generally regulated as follows:

a. For lights of the first order, 1.1 inch.

b. For lights of the second order, 1.0 inch.

c. For lights of the third order, 0.94 inch.

d. For lights of the fourth, fifth, and sixth orders, 0.87 inch.

e. When the height of the tower is such as to require the inclination of its lens for *dip*, the burner is to be elevated proportionally to this inclination, provided the elevation is not greatly in excess of what the manufacturer adjusted the apparatus to. In that case, the apparatus itself must be *readjusted*, which, however, can only be safely done in a shop or by the manufacturer.

f. That the crown of the burner be perfectly level.

4. The several operations necessary to satisfy these three conditions are generally executed in the following order:

a. The centre, or focus, of the lens is determined by the intersection of two threads fastened, respectively, to special nuts on two of the uprights, and drawn diametrically across.

b. In the third order lenses (in which the uprights are not diametrically opposite) one end of each thread passes through a nut in the upright, and the other end through holes in the middle of two small flat rods of iron that are screwed horizontally upon adjacent stanchions for the purpose of centering.

c. On the burner is adjusted the gauge, or in the absence of the gauge a scale graduated to inches and tenths of inches will be used, which has already been mentioned, and which is distinctly marked.

d. By means of the leveling nuts of the tripod, the lamp is brought nearly to its proper height; on the crown of the burner is then placed a small spirit level, and the lamp is leveled accordingly.

5. To centre the burner—that is, to make the mark of the gauge correspond with the intersection of the two threads—the upper nuts of the screws are loosened, and the lamp is moved horizontally as much as may be found necessary to put it into its proper position.

a. Finally, the small spirit level is replaced on the crown of the burner, and if it is found to be no longer horizontal, it is to be restored to this position, observing at the same time not to neglect the two first conditions relative to the centering and to the height.

b. To make an illuminating apparatus produce its greatest effect, it is

necessary that its axis should be horizontal, and that the centre of the flame should be placed in the focus.

6. In *reflector apparatus* the lamp is so arranged that there is not much risk of the burner getting out of the proper focus, but it is essential to be assured, from time to time, *that the axis of the reflector is perfectly horizontal*, except in special cases, which will be treated of elsewhere. This can be tested by a simple plumb-line held against the outer edge of the reflector.

7. In *all lens apparatus* it is necessary to frequently examine and see if the burner is placed exactly in the axis of the apparatus, and at the proper distance below the focus; that is to say, for a small apparatus, (fourth, fifth, and sixth orders,) 0.87 inch below it, (XXXV,) and if not, to so place it.

8. *To determine this, draw two threads across each other at right angles, using the small copper buttons placed in the interior of the uprights for fastenings*; the burner will be properly placed when *its centre corresponds with the point where the two threads cross*, and its top even with these threads in apparatus where the buttons are themselves placed at 0.87 inch below the focal plane, or that distance below the threads when the buttons are placed in the middle of the uprights of the apparatus. (XXXV, a, b, c, d.)

LAMPS, OIL, &c.

XXXVI.—SERVICE LAMPS.

1. In all light-houses *the lamps in use must be thoroughly cleaned once a week with ley or soap and hot water, (soap suds.)*

2. When a lamp has been in use *two weeks*, it is to be removed and a spare one put in its place early in the day, and fitted for use in the evening.

3. The lamp which is removed after two weeks' constant use *is to be thoroughly cleaned and kept in order*, ready to supply the place of the one in use in case of need.

4. When a lamp gets out of order the fact must be reported immediately to the light-house Inspector of the district, and if it has to be sent from the light-house for repair, the keeper will attend personally to see that it is carefully and properly packed for transporting.

XXXVII.—SPARE LAMPS.

1. A *spare lamp* of the order in use in the light-house *must be kept always at hand, and in readiness for immediate use*, in case of accidents, and another spare one, properly packed and cared for, must be kept in the storeroom, so that there will always be three lamps at each light-station. This applies particularly to mechanical lamps, as but two float lamps are required.

XXXVIII.—ROD OR STUDENTS' LAMPS.

1. A *rod or students' lamp must be kept filled*, trimmed, and ready for instant use, as a substitute for the service lamp in case it becomes necessary to remove or extinguish the service lamp for any purpose whatever, while the spare lamp is being placed in position.

XXXIX.—THE ALARM BELL, (CARRILLON.)

1. To aid the keepers, *an alarm bell* is attached to the multiple wick, overflow service lamp of lens lights.

2. The escapement of this instrument is retained by the end of a lever, supporting at its other extremity a cup pierced with a small hole.

3. This cup is placed under the spout of the dripper of the burner, and as long as it is kept full of oil by a proper overflow from the waste oil of the burner it sustains its counterpoise; but if the supply of oil should fail, the cup will soon become empty, and the counterpoise descending raises the stop of the hammer of the alarm, which is then set in motion, and announces to the keeper on watch that the burner is not receiving a full and proper supply of oil from the pumps or reservoir, as the case may be.

4. *Keepers must not omit to attach the alarm bell to the lamp* immediately after lighting the lamps in the evening, before leaving the lantern.

XL.—MEASURES TO BE TAKEN IN CASES WHEN THE BURNER OF THE LAMP IS NOT SUFFICIENTLY SUPPLIED WITH OIL.

1. In case the keeper on watch has neglected the lamp of the apparatus, and is warned by the alarm bell that the supply of the oil has diminished or ceased, he must enter immediately into the apparatus and aid the action of the pumps (if a pumping lamp) by a gentle effort applied to the crank in the direction of the pressure of the clock weight. He must then examine whether it be necessary to change the burner, or even the lamp in use.

2. If it be a moderator or hydraulic lamp, the keeper must lose no time in remedying the defect of a proper flow of oil in the manner prescribed for managing these lamps. (See directions for managing the different lamps.)

XLI.—HEATERS.

1. When the cold is so intense as to render the oil too thick for burning, the following precautions should be observed in performing the evening duties:

2. An hour before sunset, the oil to be used in the lamp must be heated until it reaches a temperature too hot for the hand to remain in it, after which pour it into the cistern.

3. Unscrew the burner, pour hot oil through a funnel into the orifice of the tube or pumps, then, after having held the burner in hot oil for some minutes, it should be replaced and lighted.

4. Then prepare and light the lamp of the *doubled-nozzled heater*, or the heating lamp adapted to the particular kind of lamp in use, and after having screwed on the washer of this little apparatus so as to make it tight, plunge it into the reservoir of the service lamp.

5. It will be necessary to observe that the wick of the heater lamp does not rise higher than a quarter of an inch above the burner, otherwise it will be extinguished by the dense smoke which will be produced.

6. Franklin's hydraulic and Funck's hydraulic float lamps do not require heaters.

7. Metallic heaters for fountain lamps must be warmed in a stove before being placed in the reservoirs of the lamps.

XLII.—PLATE GLASS OF THE LANTERN.

1. The plate glass of the lantern must be carefully dusted, and then wiped off, every day, and if it becomes necessary, it must be *washed with clear fresh water*, to remove *sea-spray* or other matter which may have attached itself to the glass and cause obstruction to the passage of the light through it.

2. When ice, sleet, or drift snow settles on the outside, or when the ice forms in cold weather on the inside of the glass of the lantern, a strong brine applied to it will remove it without difficulty, and, in extreme cases, a small quantity of spirits of wine may be employed with advantage for the same purpose.

3. The plate glass of the lantern must be kept at all times during the exhibition of the lights entirely free from dampness or moisture by frequently wiping it off both outside and inside with clean, dry towels.

4. Should the plate glass become discolored from deposits from the dome or frame of the lantern, the discoloration must be removed by the application of rouge powder, whiting, and spirits of wine, in the manner prescribed for using these articles.

5. Spots or stains which cannot be removed with the ordinary and prescribed means must be removed by the use of *oxalic or muriatic acid in a very dilute state*.

XLIII.—STORM PANES OF GLASS FOR LANTERNS.

1. Storm panes of plate glass, which are furnished properly fitted for use, must be kept at hand and in readiness for immediate use in case of the breakage of the glass during the night.

2. When it becomes necessary to use these "*storm panes*" at night, the keeper will lose no time next morning in replacing the broken pane of glass by a spare one.—(See directions for doing this.)

XLIV.—GLAZING.

1. The glazing of the frames of the glass, and of all the joints of the lantern through which the rain may penetrate, ought to receive the greatest possible attention and care.

2. The putty should be made of two parts of whiting and one part of white lead; the whole pulverized and worked into a stiff paste with boiled linseed oil.

RENEWING THE GLASS OF LANTERNS.

1. As keepers of lights are required, when the glass of the lantern is broken, to replace it themselves without delay, it is proper to enter into some details on the subject.

2. The diamond is the same as the ordinary glazier's diamond, except in having more strength.

3. To detach the piece after having used the diamond, strike lightly the opposite side of the plate with the end of the handle of the instrument; this will develop the crack, and a slight effort will suffice, ordinarily, to detach the piece to be removed.

4. If the section presents any irregularities, they must be removed by means of a glazier's pincers.

5. The glass, thus cut according to the requisite dimensions, ought to be ground level on its two sides, and square upon its horizontal joints.

6. This work is executed by rubbing the edge of the glass upon a cast-iron plate covered with sharp sand, which is kept constantly wetted during the operation.

PLACING THE PLATES OF GLASS OF LANTERNS.

1. It is highly important to leave about one-twelfth of an inch play all around the glass, in putting it into its frame. If it touch against the frames, it will be greatly exposed to the risk of being broken, during high winds, by the oscillation of the lantern; and besides, if less than one-twelfth of an inch space be left between the glass and the frame, the putty will fill such thin joints only imperfectly.

2. Thin cleets of lead are employed to rest the glass upon in this glazing.

3. Whenever it is requisite to repair the glazing of a frame, in which several plates of glass rest one upon another, before renewing a lower or intermediate plate, it will be necessary to remove every piece above it belonging to that frame.

4. In jointing two pieces of glass thus composing part of a frame, cover the lower edge with putty one-tenth to two-tenths of an inch in thickness, and then place on it two small slips of lead, upon which let the edge of the upper plate of glass rest, the weight of which will press out the excess of putty over the thickness of the two leaden slips.

5. This excess of putty must be removed immediately by the glazing-knife, taking care to preserve the lines of the edges smooth and clean throughout their extent.

6. The putty on the outside of a frame should be laid even and flush with the face of the sash.

7. In replacing the outside slats of the sash, it must never be forgotten to put a small quantity of putty over the head of each screw after it has been screwed home, for this serves to retain it in its place.

LINSEED OIL, BOILED OIL, AND UNGROUND WHITE LEAD.

1. The ordinary supplies of these substances are designed, with the addition of whiting to them, to make the putty necessary to the glazing of the lantern, painting, &c.

XLV.—INTERIOR OF LANTERNS.

1. The *interior of all light-house lanterns must be kept well painted white by the keepers*, (who are furnished by the supply vessels with an ample quantity of *white zinc* paint ground in oil and the necessary quantity of boiled linseed oil and spirits of turpentine for the purpose,) and washed, and wiped off, as often as necessary to remove all dust, soot, grease, &c.

2. *Cleaning-rags, chimneys, trimming-scissors, brushes, oil measures, chairs, stools, and the like, must be removed from, and kept out of, the lantern while the light is burning.*

3. Utensils of all kinds must be kept in their proper places in the room immediately below the lantern, or in the store room.

4. When the weather becomes sufficiently cold to require fire in the stove, the temperature of the interior of the lantern must not be raised *more than is absolutely necessary to keep the oil in a fluid state* while the lamp is burning.

XLVI.—LIGHTNING RODS.

1. Keepers are particularly cautioned not to neglect the lightning rods attached to the towers and dwellings. Care must be taken to ascertain that they are not injured by being disconnected or broken, and that they lead away from the building, and are sufficiently deep in the ground to reach wet earth. *Any injury to the lightning rod must be reported at once.*

XLVII.—ISSUE OF OIL FOR DAILY USE.

1. Light keepers are required to observe and conform to the following directions :

a. The oil required to fill the light-house lamp is to be taken daily from the air-tight oil butts, and *the exact quantity used for filling the lamp noted at the time in the expenditure book*, opposite to the proper day and month.

b. No greater quantity of oil is to be drawn from the oil butt than it may be supposed will be required for filling the lamp reservoir on each day.

c. When oil is drawn from the oil butts, the exact quantity taken must be noted on a slate, or in a note book, to be kept in the oil room.

d. In case there should be a small quantity of oil left in the carrier or measure after the lamp reservoir has been filled, it must be measured, put back into the butt, and the quantity deducted from that noted on the slate or memorandum book, and the remainder will be the quantity to be entered in the expenditure book for that day.

e. If the oil carrier holds more oil than is necessary to fill the lamp reservoir, *a mark must be made on the inside of it*, to show how high the oil must come in it, to exactly fill the reservoir.

TO PREPARE A LAMP FOR LIGHTING, AND TO DETERMINE THE DAILY QUANTITY OF OIL TO BE CHARGED AS EXPENDED IN THE FIRST, SECOND, AND THIRD ORDERS, AND OF THE FOURTH ORDER WITH DOUBLE WICKS WHEN SUCH IS USED.

a. *The burner being perfectly clean, wicked anew, or the old wick carefully trimmed*, in conformity to the printed directions, and the lamp reservoir being empty and perfectly clean, the oil which has been previously drawn from the butt is to be taken into the lantern in the oil carrier and the lamp reservoir filled with it.

b. *The exact quantity used* from the carrier to fill the reservoir and noted on the slate or memorandum book is then to be entered in the expenditure book in the proper column for that day and month; and in the column of remarks, opposite to the day and quantity charged as expended, is to be written "LAMP FILLED."

c. The next morning, after the lamp is extinguished, the oil remaining in the overflow reservoir is to be drawn off, as low as it will run by the cock, and any oil remaining in the reservoir is to be taken up with a clean sponge or towel and squeezed into the carrier with that drawn off by the cock.

d. If the oil which has passed through *the burner is not fit for burning*, it must be carefully filtered for future use.

e. All oil, whether it has passed through a lamp burner or not, *except*

lard oil, if to be used in *mechanical* or *moderator lamps*, must be carefully filtered before it is put in the reservoir for burning.

f. To the oil drawn and taken from the overflow reservoir, add a sufficient quantity from the butt to refill the lamp, noting on the slate or memorandum book the quantity drawn from the butt.

g. When ready to fill the lamp reservoir, the oil will be drawn into a clean carrier and put into the lamp reservoir.

h. The oil drawn from the butt to make up the necessary quantity for filling the lamp reservoir (deducting any oil remaining in the carrier and returned to the butt) will be the quantity to be entered as expended for that day.

i. To determine what quantity of oil it will be necessary to draw from the butt each day for filling the lamp reservoir of a mechanical or moderator lamp, it will only be necessary to insert a rod into the carrier and fill to the mark on it, up to which the oil reached at the time of the first filling, or to note by a mark made on the inside of the carrier when the lamp was filled what level the oil reached.

j. The quantity of oil charged as expended on the first day will be the quantity required to fill the lamp reservoir, and that taken from the butt on the second and succeeding days to replenish it will be the actual quantity consumed by the light-house lamp the previous night.

k. The quantity of oil required daily, after the lamp reservoir has been once filled, for the succeeding night's consumption, will be that necessary to fill the reservoir to the usual standard height as shown by the mark on the inside, or by mark upon the gauge rod.

l. The changes in the lengths of the nights being gradual, the difference in the consumption from one day to the next will be very small; but not too small to be determined within approximate limits by using the small measures provided, and referring to the lengths of night's tables, and the estimated hourly consumption of the lamp, which multiply by the number of hours for the night, from sunset to sunrise.

m. In the expenditures of oil, the actual quantities, as shown by actual measurement, must constitute the daily entry of expenditures, as no computation, guessing, or other approximate means of arriving at the results will be permitted or overlooked.

XLVIII.—ECONOMY OF OIL, ETC.

1. No unnecessary lights will be allowed in the dwellings of light keepers, and no lights are authorized to be kept burning in chambers or elsewhere after the inmates have gone to bed, except the hand lantern to be used in the light-house tower during the night by the keeper or assistant keeper.

2. Oil that has become unfit for use in the light-house lamp is to be used exclusively in the hand lamps for the tower, and in the lamps in the keeper's dwelling.

3. Oil is not under any pretence to be taken from the butt for use in the hand or house lamps so long as there is any oil which has passed through the light-house lamp, drippings, or other oil with sediment in it on hand.

4. Drippings from the lamps; oil which has passed several times through the burner; oil taken from the bottom of the butts; and all oil which is found to be unfit for use in the light-house lamp after it has been properly filtered, must be kept in a separate oil butt or other proper vessel and tightly covered.

5. When there is a sufficient quantity collected, and sufficient time

has elapsed for it become well settled, that part of it which has become clear, is to be carefully drawn or pumped into a clean vessel; *is to be strained and used in the light-house lamp*, and the remainder is to be left to be filtered and used in the hand and house lamps.

6. *Oil which remains at the bottom of the refuse oil butt or vessel, and which is unfit for burning in any of the lamps, may be used as far as necessary, for cleaning the brass-work of the apparatus and utensils by mixing it with rotten stone*

7. *Oil is not to be sold, loaned, or given away, nor appropriated to any other purposes whatever than those specified in the printed regulations for the light-house service.*

8. Should the light-house lamp burn badly during any night on account of the thickening of the oil from too long use, or from its having passed too often through the burner, the lamp must be thoroughly cleaned the next morning, and the oil removed from the reservoir to the refuse oil butt, and the quantity thus set apart as refuse oil must be noted in the column of remarks on the expenditure book opposite the day.

9. When the lamp and reservoir shall have been *thoroughly cleaned*, a new supply of oil must be taken from the butt, *well filtered*, (if not lard oil,) and then put into the reservoir, proceeding as in XLVI, and noting in the column of remarks "*lamp filled.*"

XLIX.—CONSUMPTION OF OIL BY THE LAMP ADAPTED TO, AND IN USE, IN THE SEVERAL ORDERS OF LENS, AND OTHER APPARATUS.

1. A first order 4 wick mechanical or other "overflow" lamp consumes about 5.6 gills per hour, or $1\frac{3}{4}$ gallons in ten hours; annual allowance 760 gallons.

2. A second order 3 wick lamp of the same kind consumes about 3.8 gills per hour, or 4 quarts and 1 pint in ten hours; annual allowance 503 gallons.

3. A third order (1 meter diameter lens) lamp, 2 wicks, consumes about 1.3 gill per hour, or 1 quart, 1 pint, and 1 gill in ten hours; annual allowance 179 gallons.

4. A third order (.75 or .70 meter diameter lens) lamp consumes about 1.2 gill per hour, or 1 quart and 1 pint in ten hours; annual allowance 160 gallons.

5. A fourth order double wick or third order small burner $\frac{3}{4}$ and $1\frac{1}{4}$ inch, consumes about 1.08 gill per hour, or 1 quart and 2.8 gills in ten hours; annual allowance 146 gallons.

6. A fourth order single wick lamp, burner $1\frac{1}{4}$ inch, consumes about $\frac{3}{4}$ gill per hour, or 1 pint $3\frac{1}{2}$ gills in ten hours; annual allowance 101 gallons.

7. A fifth order consumes about 0.56 gill per hour, or 1 pint 1.6 gill in ten hours; annual allowance 75 gallons.

8. A sixth order, with the same size burner, the same quantity.

9. A sixth order, with 0.83 inch diameter burner, consumes about 0.37 gill per hour, or 3.7 gills in ten hours; annual allowance 50 gallons.

10. An inch diameter burner, fountain lamp burner, consumes about 0.37 gill per hour, or 3.7 gills in ten hours; annual allowance 50 gallons.

11. A $\frac{7}{8}$ -inch diameter fountain lamp burner consumes about 0.3 gill per hour, or 3 gills in ten hours; annual allowance 40 gallons.

12. A $\frac{3}{4}$ -inch diameter fountain lamp burner consumes about 35 gal-

lons per annum. (See sizes of burners of lamps for different orders of apparatus.)

13. All *apparent deficiencies of oil or other supplies*, and all excessive expenditures, will be rigidly investigated by the Inspector or other authorized person, and the keeper held accountable for all articles not satisfactorily accounted for.

L.—OIL BUTTS.

1. The oil butts containing oil *must be kept tightly covered* to exclude the air from the oil, and the keepers are required to see that the covers are properly placed as soon as the butt is filled with oil, *and then fill up the space formed by the outer rim, into which the lid fits, with refuse or other oil, and close carefully both the air and draw-off cocks, placing the dripping bucket under the latter, to catch the drippings.* (See placard order.)

2. When oil is required from a butt, *the cock must be turned to admit air into the butt until the oil runs freely*; but the air cock must be closed again immediately after the necessary oil has been drawn off.

3. As soon as all the oil, suitable for burning in the light-house lamp, is taken from an oil butt, the butt must be taken from its stand, the oil remaining in it removed into the refuse oil butt, the butt carefully and thoroughly cleaned, turned bottom up to dry, and when perfectly dry it is to be replaced on its stand, *the cover put on it, made airtight with refuse oil, and both cocks properly closed.*

4. On the annual visit of the supply vessel, or on the receipt of any oil for use in the light-house, the oil butts are to be examined and carefully and thoroughly wiped out with dry towels before putting the oil into them.

LL.—USELESS AND CONDEMNED ARTICLES.

All empty oil casks, condemned oil, other useless supplies, and all articles not adapted to the use of the light station, are to be delivered to the masters of the supply vessels when they make deliveries of annual supplies, for which the keepers will obtain duplicate receipts; *one of which they will transmit to the light-house inspector* for the information of the Light-house Board, and the other be kept as evidence that proper disposition has been made of the public property.

LII.—BOATS.

1. The boats that may be allowed at special light-stations and on board of light-vessels to enable the light keepers to perform their public duties properly, and to procure provisions for their families; *are not provided for their mere personal benefit and convenience, nor as an addition to, or a part of their compensation, but as a necessary appendage to the particular light-station to enable the keeper to communicate with points only to be reached by water*; and those keepers who are furnished boats are prohibited from using them for any other than the above-mentioned purposes; and especially are they prohibited from using, lending, or hiring the boats thus placed under their charge for freighting or wrecking goods, wares, or merchandise, or for fishing with seines, ferrying, or for taking passengers for a pecuniary consideration.

2. As a general rule, boats will not be allowed to light-houses established on the main land.

3. In the selection of boats for those light-stations coming within the rule allowing them, special care is required to be taken by the Inspector to prevent those *not suited to the special public wants of the station and the character of the service being furnished.*

4. Any keeper, *in disregard of these requirements*, who allows the boat furnished to his station to be lost or injured by neglect, or improperly used or injured by others, will be required to make good all damage at his own cost and expense.—(See General Order Circular.)

LIII.—RETURNS, ETC.

1. Keepers are required to make up their quarterly returns promptly at the close of each quarter-year, and transmit them to the address of the light-house Inspector of the district for examination, and, if found to be correct, entry on the books of the Inspector's office, and transmission to the Light-house Board.

2. In addition to the quarterly return of daily expenditures of oil, wicks, and chimneys, and the abstract of the aggregate receipts and expenditures during the quarter at the back of it, (Form No. 45,) and the quarterly returns of shipwrecks near the light-station, and of the number of vessels which have passed within sight of the light during the quarter, a RETURN of all articles and quantities received and expended during the year from the 1st July to the following 30th of June, and a correct inventory of all public property at the light-station at the close of the fiscal year, will be made up from the expenditure books according to the printed forms Nos. 48, a, b, c, and transmitted immediately thereafter to the Light-house Inspector of the district, to be examined, entered in the books of his office, and, when found to be correct, transmitted to the Light-house Board.

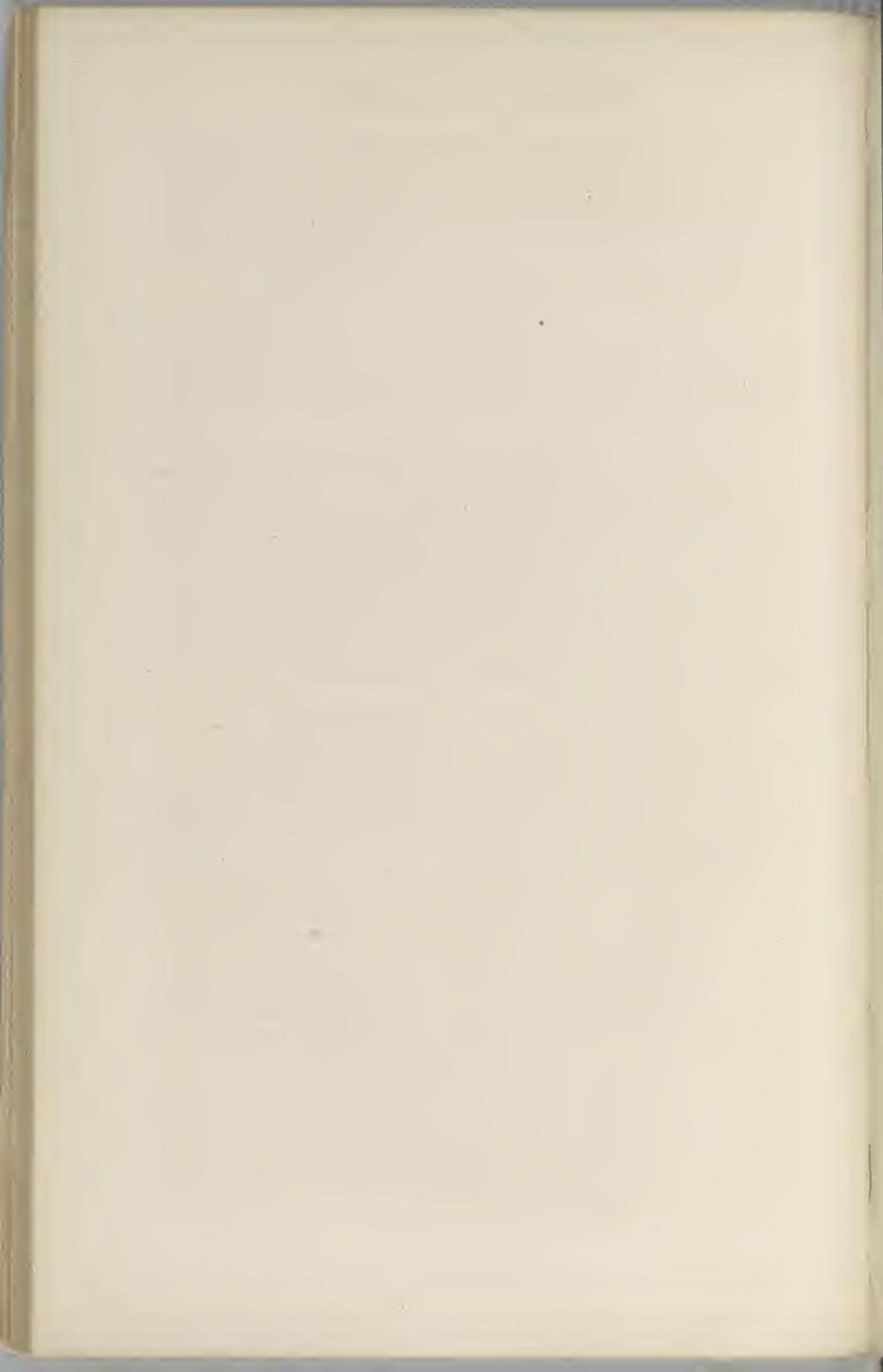
3. When a light keeper *resigns or is removed*, a correct inventory of all public property under his charge will be made up in the presence of his successor, who will retain a copy and sign two others as receipts to the retiring keeper, one of which must be transmitted to the Inspector.

4. In case of the death of the keeper, the successor will receive from the widow, or assistant, or other responsible person in charge of the light, the supplies and other public property, and receipt for them as in the case of resignation or dismissal.

5. No light keeper, or representative of a light keeper, will be entitled to receive any balance on account of salary until he shall have accounted satisfactorily for all the public property in his charge, or which should have been in his charge, at the time of the resignation, dismissal, or death of the keeper.

6. No keeper should sign receipts upon entering upon duty, or for supplies from the supply-vessel, or from any other source, unless he is satisfied that the articles and quantities are correctly stated, as keepers will be held strictly and pecuniarily responsible for all articles and quantities they receipt for, and a subsequent discovery of error in their receipts will not relieve them from this responsibility.

7. All articles condemned as unfit for use are to be retained for exhibition to the Inspector or master of the supply-vessel, and no alleged deficiency of utensils, brooms, brushes, or other fixtures, will be supplied unless the worn-out or condemned articles are kept and exhibited when called for, and the keeper will be held responsible for their original value if not satisfactorily accounted for.



INSTRUCTIONS AND DIRECTIONS
TO
KEEPERS OF LIGHT-VESSELS

GENERAL INSTRUCTIONS.

LIV.—DUTIES AND RESPONSIBILITIES.

1. The lamps shall be lighted punctually *every day at sunset, and extinguished at sunrise.*—(See Directions.)

2. The lamps shall be *kept burning bright and clear, every night, from sunset to sunrise*; and in order that the greatest degree of light may be uniformly maintained, the wicks must be trimmed every four hours, or oftener, if necessary, and clean glass chimneys fitted on. Special care must be taken to cut the tops of the wicks exactly even, to produce flames of uniform shape, free from smoky points when they are at their greatest attainable height, at which they must be kept during the entire time the lights are exhibited.—(See Directions.)

3. The keeper is held responsible for the careful watching and trimming of the lights throughout the night by careful, competent, and reliable persons, who have been instructed in the duties of the service, and is expected to be in attendance during the day, never absenting himself from duty without permission from the district Inspector, except in the cases hereafter provided for.

4. The keeper will be particular to note in his journal the time at which all lights usually visible from the vessel under his charge are lighted up; he will also specify the hour of the disappearance of any of them, and note at such times the condition of the weather and the character of the atmosphere.

5. The keeper must clean the glass of the lantern *within and without, by night as well as by day*, particularly from the drift-snow, sleet, and the moisture which is liable to accumulate in the interior of the lantern, and polish and clean the reflectors and lamps, trim the lamps, *and put the vessel in perfect order, by 10 o'clock a. m. daily*; and be very particular with the order and cleanliness of the apartments, holds, storerooms, and berths of the crew.

6. The routine duties of cleaning the lamps, filling and trimming them, polishing the reflectors, &c., must be arranged in such manner by the keeper as to give each person on board his fair proportion of duty.

7. The reflectors must be carefully dusted with a feather brush, or a piece of clean soft linen, before commencing to clean and burnish them, and special care must be taken to see that the chamois skins used in rubbing them are entirely free from dust and gritty particles. Without such precautions the cleaning process will only tend to scratch and seriously injure the reflectors, and impair their power of transmitting the rays of light from the burner.

8. *The great art of keeping reflectors in proper order consists in the daily, patient, and skilful application of manual labor in rubbing their silvered surfaces, beginning at the centre and gradually working outwards, with a circular motion of the hand. No damp or wet substance should ever be applied to the silvered parts of metallic reflectors. If their lustre becomes dim, a little carefully-prepared rouge, of the finest kind, in the state of an impalpable powder, may be used on the dry and clean chamois skin as a polisher.—(See directions for preparing and using rouge and whiting for cleaning apparatus.)*

9. If spare metallic reflectors have lain long unused, and have consequently become covered with a thick and dark coating of oxide, rouge powder mixed with oil may first be applied to remove the film of oxide, after which, dry rouge powder should be dusted on the reflector, and polished in the usual way, with a soft dry chamois skin. It is the more important to observe these directions, inasmuch as *the polish of silver plate is much more easily injured than that of glass.*

10. The chamois or buffskins must *always be kept, when not in use, in the closely-covered tin boxes, provided for the purpose, to insure them against dampness and dust.*

11. The backs of reflectors and other brass work should be cleaned with pulverized rotten stone mixed into a paste with pure lamp oil.—(See directions for preparing and using rotten stone.)

12. The upper deck of the vessel must be thoroughly washed down every morning, *except in freezing weather, and, when necessary, sand and stiff brooms may be used; but holystones must not be used more than once a month. The between-decks are only to be wetted occasionally, and then in the forenoon, in good weather, so that they may be thoroughly dried before night.*

13. A log-book shall be kept on board of each light-vessel by the person in charge of the watch for the time being, in which all the duties of the vessel and occurrences of importance shall be recorded, stating accurately *the times at which the lamps are trimmed during the night; the length of time which intervenes between lowering the lantern and again hoisting it after the lamps are trimmed; the number of men on duty during each watch; the direction and strength of the wind; the state of the weather at noon, 8 p. m., midnight, and 8 a. m., and during gales, as much oftener as circumstances may require to make the record useful and intelligible; also the times at which the moorings are examined, and the condition in which they are found, &c. This log must be copied from the slate into the book by the keeper or mate, and must be signed by the person in charge of the watch for the time being.*

14. The keeper must take an inventory of all anchors, cables, sails, boats, and all furniture, materials, stores, and supplies of all kinds, immediately after taking charge of a new light-vessel, or on succeeding a former keeper, which, duly signed, must be transmitted to the Inspector, and a corrected list made out on the first days of July and January, annually, specifying at the bottom, in detail, those articles which have been expended, and those which are required for the next half-year, must be signed by the keeper, and sent or delivered to the Inspector, a record or copy of which must be kept on board the vessel.

15. The keeper is held responsible for the safety and good order of the stores, utensils, and apparatus of every description, and for everything being put to its proper use, and kept in its proper place. *He shall take care that none of the stores or materials are wasted, and shall observe the strictest economy in the use of stores, and the most careful man-*

agement of the apparatus, yet, so as to maintain, in every respect, the best possible light the apparatus will produce.

16. He is, on no account, to leave the turning keys attached to the cocks of the oil cisterns after drawing oil, but shall remove and deposit them on the oil tray beside the measures, or hang them up in some safe and convenient place.

17. He shall keep a daily account of the quantity of oil and wicks consumed, and number of chimneys broken, in the journal books, to be kept at each station for the purpose.

18. At the end of each quarter he shall make up and transmit to the district Inspector a return, which shall be an accurate copy of the journal for the preceding quarter.

19. He is also required to take notice of any shipwrecks which may happen in the vicinity of the light-vessel, and to enter an account thereof in the log-book. In that account it shall be stated, *if practicable, whether the light was seen by any one on board the wrecked vessel, and recognized by him, and how long it was seen before the vessel struck.* A copy of this entry shall form the shipwreck return, and be forthwith forwarded to the Inspector.

20. A book containing an account of the vessels passing the light-vessel shall be kept, and a schedule, showing the number of such vessels in each quarter, shall be sent to the district Inspector.

21. The light keeper shall take especial care, at all times, *that neither lucifer matches, nor anything else which is easily ignited, lighted lamps, candles, or fires, be left anywhere unattended in the vessel, so as to endanger the public property by fire.* When the weather is such as to require fire in the stove at night, every precaution must be taken by the watch on deck, and by the keeper, to prevent accidents from it.

22. *The fire-buckets are to be kept on deck, in the most convenient place for use, and, when the temperature will permit, filled with water at sunset every day; and they are, on no account, to be kept between decks at night.*

23. Two draw-buckets must be kept properly strapped and fitted (one on either side) and the end of the bucket-rope made fast to the vessel when there is no wash deck-pump.

24. The wash deck-pump must be examined frequently, and kept in good order.

25. The light keeper shall, *under no circumstances, use Tripoli soap or Tripoli powder for cleaning the silvered parts of the reflectors, nor any other cleaning materials than the rouge, whiting, rotten stone for the backs of the reflectors and other brass work, buffskins, cleaning cloths, &c., furnished by direction of the Light-House Board for the purposes designated in the directions to light keepers.*

26. Each package or parcel of rouge and of whiting must be examined by the keeper before he uses it, to ascertain that it is free from grit and other impurities, and should it be found to be of *bad quality, and likely to injure the apparatus, it must not be used.*

27. *A regular watch must be kept on deck at all times, the pump-well of the vessel must be sounded at least once during every watch at night, and in bad weather every hour, and the result reported to the keeper, should it be necessary.*

28. *The keeper must see that the watch is set, and everything in good order, every night before leaving the deck.*

29. The lightning conductors (if fitted with outriggers and not led down to the copper below the water line and secured) must be rigged

out, and led fair, clear of all iron and the ship's side, every day at sunset, and rigged in at daylight, except in bad weather, when they must be kept rigged out during its continuance.

30. In bad weather he is required to give his constant personal attention to the duties of the vessel.

31. *During bad weather the spare anchor must be kept ready for letting go, and a proper range of cable on deck, bitted and stoppered, to bring the vessel up in the event of dragging; and a sufficient watch must be kept constantly on deck to meet any emergency.*

32. The deep-sea lead must be kept overboard, and a careful hand stationed by it, whenever the weather is such as to endanger the safe riding of the vessel.

33. Should the vessel drag her anchors, the keeper is carefully to consider whether she has driven to such a distance, or in such a direction, as to make it dangerous to shipping to continue to show her lights; and if the distance, or direction, *be not such as to endanger the safety of vessels running on their course*, the lights and day-marks are to be continued in the usual manner; but should the light-vessel have driven so as to be dangerous or useless as a guide to shipping, the usual lights and day-marks must in that case be discontinued, and the lanterns and other distinguishing marks be carefully masked.

34. The moorings must be examined at least once a month by heaving in the chain, selecting such times as are best adapted to the purpose, but particularly after heavy gales; and in every instance a strict and careful examination of the chains, shackles, swivels, and studs must be made by the keeper, the result noted in the log-book, and reported to the Inspector of the district without delay.

35. If he has any reason to *doubt their good condition at any time*, he must report the fact without delay to the district Inspector.

36. Reports of the examinations of the moorings and of the absences of the keeper, mate, and crew must be carefully and correctly made out from the log-book at the end of each month, and delivered or transmitted to the Inspector of the district.

37. The keepers of light-vessels must *not slip their moorings; nor will they be permitted to leave their stations, except by written permission from the Inspector of the district, (and after due notice shall have been given of such intention,)* unless the vessel and crew would be kept in great peril by remaining.

38. The ballast must be removed, *and the hold thoroughly cleaned and whitewashed, at least once every six months.*

39. Water must not, under any pretence, be let into the hold; but, on the contrary, the vessel *must be pumped out every day*, before 8 a. m., as dry as the pumps will make her; and if water settles forward or aft which the pumps will not reach, it must be bailed out with buckets, and dried with swabs.

40. During the summer months, the wind-sails are to be kept up and the awnings spread whenever the weather will permit; and every precaution must be taken to keep the vessel, dry, cool, and comfortable between decks.

41. *Wet clothes, or bedding, must not be kept below.* During the stormy season, the sails must be kept bent, and frequently loosed to dry when the weather will permit.

42. Every effort must be made to keep *the between decks and holds dry and thoroughly ventilated*; and once a month in summer, and as often

as the weather will permit it in winter, (not oftener than once a month,) the bedding of the crew must be aired and shaken on deck.

43. The *life-boats and other boats must be examined frequently*, and every care bestowed upon them to insure their preservation and usefulness in case of need.

44. When stores of any kind are to be received on board for the use of the light-vessel, the keeper shall attend and give his assistance. He shall satisfy himself upon these occasions of the quantity and condition of the stores received, which must be duly entered in the store books and quarterly-return book; *and he shall see that the oil is emptied immediately into the cisterns or oil butts.*

45. Keepers are strictly *prohibited from signing any receipts for supplies, rations, fuel, or any other public property, unless they are fully satisfied that the quantities specified have been delivered.*

46. The light keeper is to make a report of the quality of the stores, in the return for the quarter immediately succeeding their receipt, *and earlier*, should circumstances render it necessary, and also for the fourth quarter annually; and this report must proceed upon special trial of the several cisterns of oil, and the other stores in detail, *both at the time of receiving them and after the expiration of sufficient time to test them fully.*

47. Should the supply of light-vessel stores at any time appear to the keeper to be getting short, so as thereby to endanger the regular appearance of the light, *he shall immediately inform the district Inspector*, and, by prudence in the management of the lights, guard against the total consumption of the supplies before others can be received.

48. The light-keeper is prohibited from carrying on *any trade or business whatever*, which will take him from the light-vessel, *or in any other manner* cause the neglect of his public duties.

49. He has permission to go from the vessel to draw his salary, to attend public worship on Sunday, and for reasonable relaxation and exercise on shore when the duties of the vessel and the state of the weather are such as to justify such absence, *but on no other occasion, without the permission of the district Inspector.* In case of sickness, or anything else happening to endanger the proper management of the light, he must report the fact without delay, to the district Inspector.

50. The mate and keeper are never to be absent from the light-vessel in bad weather, or at night, at the same time.

51. The light-keeper is required to be sober and orderly, to exact from the crew the strictest obedience to his orders, and to treat persons who visit the light-vessel with civility. *He is prohibited from selling any malt, vinous, or spirituous liquors, and from allowing any to be sold or used on board the light-vessel under his charge.*

52. The keeper *must hail all steamboats or other vessels* which hover about the light-vessel under his charge, and which may prevent the lights from being seen, *and request them to keep off; and under no pretence shall he allow any vessel to make fast alongside or astern of the light-vessel.*

53. The seamen and others, constituting the crews of light-vessels, *are required to conduct themselves in an orderly and subordinate manner; obeying promptly and cheerfully all the orders from the inspector and keeper.*

54. Any neglect of duty, or disobedience of orders, *must be reported immediately to the district Inspector*, who will inquire into, and report the facts and circumstances of the case to the Board.

55. Crews of light-vessels will be allowed *all reasonable and proper indulgence in visiting their friends and families on shore*, especially during the summer months; but the Inspectors will regulate the number of persons who may be absent at one time from the vessel, and divide the general times and duration of visits to the shore.

56. Light-vessel keepers, mates, and foremast men *are all required to live and mess on board of the light-vessel to which they are attached*. The rations allowed, and the fresh or other provisions purchased with the commutation money for rations, are not to be taken out of the vessels.

57. Muster-rolls of light-vessels must be made out from the log-books at the end of each quarter year, showing the names, rates of monthly pay, and all changes in the crew on board during the quarter, and transmit them, duly certified by the keeper, to the Inspector of the district.

58. The light keeper is to observe that the above general regulations are without prejudice to any more special instructions which may be made applicable to any particular light-vessel, or to such orders as may, from time to time, be issued by the Light-house Board.

59. All official communications must be transmitted to the district Inspector, except in cases of great emergency, when they may be sent direct to the Light-house Board, under cover to the honorable Secretary of the Treasury.

60. These instructions are to be hung up in a conspicuous place in the apartments of the vessel, *and the keeper is required to make himself perfectly acquainted with them, and to have them read on the first Monday of every month to all the crew*.

61. The breach of any of the foregoing instructions will subject the offending light keeper, or others, to the displeasure of the department, and, *in the absence of extenuating circumstances, to dismissal*.

REGULATIONS IN REGARD TO RATIONS FOR LIGHT-VESSELS.

1. The annexed ration table exhibits the component parts and aggregate quantities of the different articles constituting the daily ration and quarterly quantities for the crews of light-vessels.

2. Commutations of *not exceeding one-third* of the whole number of rations allowed on board of any light-vessel, may be allowed at the current contract price of the rations, upon satisfactory assurances being given by the keeper and crew to the Inspector of the district that the commutation money will be properly and judiciously used in purchasing *fresh meat, green and other vegetables, and fruits* for the use of the messes on board the vessel, that the money shall not be applied to any other object than for mess purposes, and that it, nor any part of it, shall not be shared or divided among the crew.

3. Commutations of rations are only *permissive*, and any failure to comply with the requirements in regard to the application of the money received for undrawn rations, will insure the withdrawal of the permission to commute, the object being to contribute to the health and comfort of the men on board of light-vessels, by affording them, in the most practicable way, the necessary fresh meat, fruits, and vegetables.

4. Light-vessels are to be amply supplied with good, wholesome drinking and cooking water for the use of all persons on board, and as far as possible, for washing the clothes of the crews when required.

5. These instructions with the ration table attached must be hung up in the apartments and cabins of light-vessels for the information of all on board.

COMPONENT PARTS OF RATIONS.

Exhibit showing the component parts of the ration to be served to the crews of light-house tenders, supply-vessels, and the light-vessels, of the United States, for each day of the week.

| Days of the Week. | POUNDS. | | | | | OUNCES. | | | | | FRACTIONS OF A PINT. | | |
|----------------------|---------|-------|--------|-------|--------------------------|----------|--------|-----------------|---------|---------|----------------------|---------------|---------------|
| | Beef. | Pork. | Flour. | Rice. | Raisins, or dried fruit. | Biscuit. | Sugar. | Tea. | Coffee. | Butter. | Beans. | Vinegar. | Molasses. |
| Sunday..... | 1 | | | | | 14 | 2 | 1 | 1 | | | | |
| Monday..... | | 1 | | | | 14 | 2 | 1 | 1 | | $\frac{1}{2}$ | | |
| Tuesday..... | 1 | | | | | 14 | 2 | 1 | 1 | 2 | | | |
| Wednesday..... | | 1 | | 1 | | 14 | 2 | 1 | 1 | | $\frac{1}{2}$ | | |
| Thursday..... | 1 | | 1 | | $\frac{1}{2}$ | 14 | 2 | 1 | 1 | | $\frac{1}{2}$ | | |
| Friday..... | 1 | | | | | 14 | 2 | 1 | 1 | 2 | | | |
| Saturday..... | | 1 | | | | 14 | 2 | 1 | 1 | | $\frac{1}{2}$ | | |
| Weekly quantity..... | 4 | 3 | 1 | 1 | $\frac{1}{2}$ | 98 | 14 | 1 $\frac{1}{2}$ | 7 | 4 | 1 $\frac{1}{2}$ | $\frac{1}{2}$ | $\frac{1}{2}$ |

QUARTERLY AND ANNUAL ALLOWANCES.

Table showing quarterly and annual allowances of rations for crews light-house tenders, supply-vessels, and light-vessels.

QUARTERLY ALLOWANCE PER MAN.

| FIRST QUARTER—JULY, AUGUST, AND SEPTEMBER. | | THIRD QUARTER—JANUARY, FEBRUARY, AND MARCH. | |
|---|--------------------------|---|--------------------------|
| Mess pork..... | lbs... 40 | Mess pork..... | lbs... 39 |
| Mess beef..... | lbs... 52 | Mess beef..... | lbs... 52 |
| Flour..... | lbs... 13 | Flour..... | lbs... 13 |
| Rice..... | lbs... 13 | Rice..... | lbs... 13 |
| Raisins..... | lbs... 6 $\frac{1}{2}$ | Raisins..... | lbs... 6 $\frac{1}{2}$ |
| Ship biscuit..... | lbs... 81 | Ship biscuit..... | lbs... 79 |
| Brown sugar..... | lbs... 11 $\frac{1}{2}$ | Brown sugar..... | lbs... 11 $\frac{1}{2}$ |
| Tea..... | ozs... 23 | Tea..... | ozs... 22 |
| Coffee..... | lbs... 5 $\frac{1}{2}$ | Coffee..... | lbs... 5 $\frac{1}{2}$ |
| Butter..... | lbs... 3 $\frac{1}{2}$ | Butter..... | lbs... 3 $\frac{1}{2}$ |
| Beans or peas..... | galls... 2 $\frac{1}{2}$ | Beans or peas..... | galls... 2 $\frac{1}{2}$ |
| Vinegar..... | gall... $\frac{1}{2}$ | Vinegar..... | gall... $\frac{1}{2}$ |
| Molasses..... | gall... $\frac{1}{2}$ | Molasses..... | gall... $\frac{1}{2}$ |
| SECOND QUARTER—OCTOBER, NOVEMBER, AND DECEMBER. | | FOURTH QUARTER—APRIL, MAY AND JUNE. | |
| Mess pork..... | lbs... 39 | Mess pork..... | lbs... 39 |
| Mess beef..... | lbs... 52 | Mess beef..... | lbs... 52 |
| Flour..... | lbs... 13 | Flour..... | lbs... 13 |
| Rice..... | lbs... 13 | Rice..... | lbs... 13 |
| Raisins..... | lbs... 6 $\frac{1}{2}$ | Raisins..... | lbs... 6 $\frac{1}{2}$ |
| Ship biscuit..... | lbs... 80 | Ship biscuit..... | lbs... 80 |
| Brown sugar..... | lbs... 11 $\frac{1}{2}$ | Brown sugar..... | lbs... 11 $\frac{1}{2}$ |
| Tea..... | ozs... 23 | Tea..... | ozs... 11 $\frac{1}{2}$ |
| Coffee..... | lbs... 5 $\frac{1}{2}$ | Coffee..... | lbs... 5 $\frac{1}{2}$ |
| Butter..... | lbs... 3 $\frac{1}{2}$ | Butter..... | lbs... 3 $\frac{1}{2}$ |
| Beans or peas..... | galls... 2 $\frac{1}{2}$ | Beans or peas..... | galls... 2 $\frac{1}{2}$ |
| Vinegar..... | gall... $\frac{1}{2}$ | Vinegar..... | gall... $\frac{1}{2}$ |
| Molasses..... | gall... $\frac{1}{2}$ | Molasses..... | gall... $\frac{1}{2}$ |

ANNUAL ALLOWANCE PER MAN.

| | | | |
|-------------------|-------------------------|--------------------|--------------------------|
| Mess pork..... | lbs... 157 | Tea..... | ozs... 91 |
| Mess beef..... | lbs... 208 | Coffee..... | lbs... 22 $\frac{1}{2}$ |
| Flour..... | lbs... 52 | Butter..... | lbs... 13 |
| Rice..... | lbs... 52 | Beans or peas..... | galls... 9 $\frac{1}{2}$ |
| Raisins..... | lbs... 26 | Vinegar..... | galls... 3 |
| Ship biscuit..... | lbs... 320 | Molasses..... | galls... 2 |
| Brown sugar..... | lbs... 45 $\frac{1}{2}$ | | |

ATTENDANCE UPON HARBOR, RIVER, PIER, AND OTHER SMALL BEACON LIGHTS.

LV.—TO PREPARE A LAMP FOR LIGHTING AND DETERMINE THE DAILY QUANTITY OF OIL TO BE CHARGED AS EXPENDED OF THE FOURTH, FIFTH, AND SIXTH ORDERS, WITH SINGLE WICKS.

1. When the ordinary fountain lamp is used in the small apparatus, the quantity of oil required to fill it must be measured from the oil carrier into the lamp feeder by one of the small measures, or, if a hydraulic lamp, according to the special directions for using them.

2. When the fountain or other lamp is first filled, *or after having been cleaned*, the quantity of oil used to fill it must be noted, and the words "*lamp filled*" written in the column of remarks, as in the case of larger lamps.

LVI.—APPARATUS AND LAMPS.

a. Fourth order apparatus, of 19.685 inches interior diameter.

b. Fifth order apparatus, of 14.764 inches interior diameter.

c. Sixth order apparatus, of 11.811 inches interior diameter.

d. Steamers' lenses, of 11.811 inches interior diameter.

e. Steamers' lenses, of 7.874 inches interior diameter.

f. Pressed or mould glass lenses in lanterns.

g. Parabolic silvered reflectors, of 21 inches.

h. Parabolic reflectors, of 12 inches.

1. The lamps used in these lights are the hydraulic (Franklin's or Funck's float) and Argand fountain. The reflector lights (both ashore and on board of light-vessels) are fitted with ordinary Argand fountain lamps.

2. The brass work of these lamps must be kept perfectly clean, and the fountains polished with pulverized rotten stone and oil.

3. The small lens apparatus is placed upon cast-iron pedestals or tripods. It is fixed ordinarily on a central pivot, and rests upon rollers in such a way as to allow it to turn with ease upon its axis.

LVII.—CONSTANT-LEVEL OR ARGAND FOUNTAIN LAMPS.

1. Constant-level or Argand fountain lamps are formed of two parts: the burner of the lamp, and the reservoir or fountain.

2. The reservoir is provided at its lower part with a valve, which lifts when the stem which is attached to it comes in contact with the bottom of the body of the lamp. A communication is thus established between the reservoir and the burner of the lamp.

3. To insure that these lamps will be regularly fed with oil, it is necessary:

a. That the extremity of the lower addition of the reservoir should be one-tenth or one-twelfth of an inch lower than the crown of the burner; and,

b. That external air should reach the lower orifice of the reservoir without obstruction, to replace the oil as it is consumed; for which purpose an opening is made in the case of the lamp.

4. Great care must be taken to keep the crowns of the burners at the prescribed distance, viz: 0.87 inch below the focal bearer of the fourth, fifth, and sixth order lens apparatus, so that as near as may be the centres of the flames will be the focus of the apparatus.

5. When the parts of a lamp become from long use or wear so loose that the keeper cannot put it in proper order, the spare lamp must be used, and the Inspector informed of the condition of the one needing repairs, so that it may be sent to the shop.

LVIII.—LAMPS OF LENS AND REFLECTOR BEACON-LIGHTS.

1. The burners of lamps used in lens and reflector beacon-lights are covered with glass chimneys, having gently curved elbows or shoulders.

2. The lower part or base of the chimney rests in a movable gallery, which is formed ordinarily of two concentric circles. It incloses the burner by a slight pressure, which can be increased at pleasure by gently bending inward with flat pliers, the elastic plates of the interior circle.

LIX.—HEIGHT OF THE FLAME.

1. The height of the flame, corresponding to the full effect of lamps of this description, is from $1\frac{1}{2}$ to $1\frac{3}{4}$ inch.

2. It is obtained by elevating to a proper point the movable gallery which holds the chimney. If that point is exceeded, the flame may grow larger, but it will be dull and red; if the error is in the contrary direction, the flame will continue to be white, but without attaining such a height as is desired.

3. If the flame cannot be kept uniformly at the prescribed height, the keeper must immediately examine into, and, if possible, ascertain the cause. It will ordinarily be found due to a dirty burner, improper flow of oil, defective wicks, or improper ventilation. If no remedy be found by changing the lamp, then the fact must be reported to the Inspector.

LX.—DOUBLE-WICK CONSTANT-LEVEL LAMPS.

1. The application of double wicks to the ordinary Argand lamps has been successfully tested, although now seldom used.

2. The only difference in the management will be to develop the flame more slowly during the first hour of combustion than in the single-wick lamps, and to use the damper very carefully in regulating the height of the flame.

3. When gas is used, there must be a water-tap at the lowest part of the pipe, and the water frequently let out and never allowed to accumulate, especially during the winter months.

LXI.—CONSUMPTION OF OIL.

1. Three sizes of burners are used in these lamps—one of them, $1\frac{1}{4}$ inch for fourth order; 0.95 inch for fifth order; and the other 0.83 inch in diameter for sixth order, measured at the middle of the annular space occupied by the wick.

2. The estimated mean consumption of sperm oil for the large burner is about $\frac{3}{4}$ gill per hour, or 1 pint and $3\frac{1}{2}$ gills in ten hours—annual allowance 101 gallons; for the 0.95 inch burner 0.56 gill per hour, or 1 pint $\frac{1}{2}$ gill in ten hours—annual allowance 75 gallons; and for the 0.83 inch burner about 0.37 gill per hour or 3.7 gills in ten hours—annual allowance 50 gallons.

Fountain lamps, 1 inch burner, consume about 0.37 gill per hour, or 3.7 gills in ten hours—annual allowance 50 gallons.

Fountain lamps, $\frac{7}{8}$ inch burner, consume about 0.3 gill per hour, or 3 gills in ten hours—annual allowance 40 gallons; and fountain lamps, $\frac{3}{4}$ inch burner, consume about 35 gallons per annum.

The consumption as above is for the most favorable circumstances.

4. A small number of lens apparatus is illuminated by ordinary constant-level lamps.

5. The general management of these lamps is the same as that of others.

LXII.—TO FILL THE RESERVOIR OF FOUNTAIN LAMP.

1. To fill a constant-level lamp with oil, remove the reservoir from its case, turn it up, and fill it through the hole left in the lower part of it; then replace it, taking care to close the valve by means of the small iron stem attached to it, so as to prevent the oil from being spilt in turning it down.—(For other lamps see Directions.)

LXIII.—TO PUT ON THE WICKS.

1. To fit a wick in its place, raise the wick-holder to its greatest height; remove it, and introduce the tin or wooden mandril designed to receive the wick; then shove down the wick to the bottom of the wick-holder, and secure it there by means of a tin ring supplied for that purpose.

2. Should the ring be missing, its place must be supplied by a thread.

3. It is very important that the edge of the wick should be cut very regular, and covered so that no projection which will interfere with the passage of the oil may be left.

4. The wick being placed, lower it to its lowest point, and cut the upper edge even with the top of the burner, in the neatest and most regular manner possible, with the sharp curved scissors.

5. This is the process for wicking all burners.

LXIV.—TRIMMING OR SNUFFING.

1. To trim or snuff a wick while it is burning, raise it so as to bring the lower part of the carbonized wick even with the edge of the burner; then proceed to trim or remove the carbonized portion. Trimming hooks and pickers are also used for removing the hard crust from the wicks.

LXIV.—HEATERS.

1. When the temperature is such as to cause fear of congelation of the oil, a heater is placed under the body of the lamp, or a copper rod placed in the lamp reservoir.

2. The former implement is composed of a cup filled with oil, and a floating taper placed in it. It is fixed to the base of the body of the lamp in the place of the movable portion, similar in shape to the bottom of the lamp, by means of the upper ring of its support.

3. Another kind of heater is a copper rod, one end of which passes through the lamp reservoir, and the other end is bent over so that it comes just above the glass chimney.

LXVI.—LAMPS TO ILLUMINATE THE WHOLE HORIZON.

1. Constant-level or fountain lamps cannot be used to illuminate the entire horizon, so that recourse must be had either to the hydrostatic or Carcel, (mechanical,) or to the Franklin or Funck lamps.

2. All these lamps are managed in the same manner that the ordinary constant-level lamps are, in so far as relates to chimneys, placing and trimming the wicks, &c.

3. At stake-light stations where there are no dwellings for the attendants upon them, two lamps or lanterns will be kept in use for interchanging daily, so that the cleaning, wicking, and filling with oil may be done away from the light-station.

LXVII.—TO PLACE THE BURNER IN THE CENTRE OF THE APPARATUS.

1. To make an illuminating apparatus produce its greatest effect, it is necessary that its axis should be horizontal, and that the flame should be placed in the focus.

2. In reflector apparatus the lamp is so arranged that there is not much risk of the burner getting out of focus; but it is essential to be assured, from time to time, that the axis of the reflector is perfectly horizontal, except in special cases, which will be treated of elsewhere. This can be tested by a simple plumb-line, held against the outer edge of the reflector.

3. In lens apparatus it is necessary to examine if the burner is placed exactly in the axis of the apparatus, and at the proper distance below the focus; that is to say, for small apparatus, (fourth, fifth, and sixth orders,) 0.87 inch below it.

4. *To determine this, draw two threads across each other at right angles, using the small copper buttons placed in the interior of the uprights for fastenings; the burner will be properly placed when its centre corresponds with the point where the two threads cross, and its top even with these threads in apparatus where the buttons are themselves placed at 0.87 inch below the focal plane, or that distance below the threads when the buttons are placed in the middle of the uprights of the apparatus.*

LXVIII.—TO LIGHT THE LAMPS.

1. To light a lamp, commence by raising the wick *about one-third of an inch* above the top of the burner, and light it *at two opposite points*, (using for that purpose the small hand-lamp (lucerne) specially designed for lighting, and nothing else, as matches, lamp-lighters, and the like, are forbidden to be used.)

2. As soon as the flame commences to rise *all around, and before it begins to smoke*, lower the wick, and place the chimney in its holder.

3. *At first keep the wick low and the chimney high; afterwards raise the wick very gradually to its proper height, and lower the chimney to its position until a clear white flame is obtained of such height as the description of lamp requires.—(See plates of flames.)*

4. To light lamps with two concentric wicks, *commence with the inner one, which should be lowered as much as possible, (without risk of extinguishing the light.)* As soon as it has caught all around, follow the same course with the outer wick. Having lighted both wicks,

commence raising them very gradually, and lower the chimney at the same time.

5. The flame of a burner of two concentric wicks requires about half an hour to reach its full development.

LXIX.—TO EXTINGUISH THE LAMPS.

1. A lamp is extinguished by lowering its wick.
2. To extinguish lamps having two concentric wicks, commence by lowering the outer one first.
3. *The chimney ought not to be removed for several minutes after, and until it is sufficiently cool to prevent its breaking by too rapid contraction of the glass, and when taken off it must be wrapped in its flannel cloth and laid in the chimney box or basket.*

LXX.—REVOLVING MACHINERY.

1. Beacon and other small lens lights are frequently revolving or fixed varied by flashes light.
2. That characteristic distinction is imparted to them by lenses of cylindrical elements, which a revolving machine turns around the apparatus; or by arranging two alternate panels like those of a fixed light, the other two being arranged to throw out rays parallel to each other as well as to the horizon. In this latter apparatus the whole revolves.
3. The revolving machinery consists of a clock-work movement, with a fly for its regulator or governor, put in play by a weight. Its motion is retarded, or accelerated, by opening or closing the wings of the fly, or by increasing or diminishing the motive weight.
4. The motion of this machinery is communicated to the frame which sustains the movable lenses, or to the whole apparatus, by means of two cog wheels, which are thrown into gear at pleasure.
5. The time of the revolutions of the apparatus must be frequently compared, and if the interval between the flashes be not correct, it must be made so by altering the fly, or the motive weight, or both.
6. "*Time-markers,*" with a long hand noting seconds, or "*time glasses,*" (sand,) will be provided, although the revolutions may be compared by a clock with only a *minute* hand by timing a number of revolutions equivalent to one or any even number of minutes.

LXXI.—LIGHT-KEEPER'S DUTIES—MORNING ROUTINE.

1. The keeper must commence the following course of duties every morning, immediately after extinguishing the lights:
 - a. If the light is a movable one, the motive weight of the revolving machinery must be wound up to its greatest height, and then fixed so that the cord of the machine will be relieved from the weight by a clutch or bar; *the machine must then be stopped, and the connecting wheel thrown out of gear.*
 - b. If the lamp is mounted on a movable table in the apparatus, the table must be lowered.
 - c. If the apparatus is raised upon a scaffolding, it must be lowered until it rests upon the service-table designed to receive it.
 - d. The directions already given must be observed in extinguishing the lamp; and the glass chimney must be carefully wiped inside and

out, and then wrapped in a dry piece of linen and placed out of the way of dust.

e. If it is a constant-level lamp, it must be removed from the apparatus and placed on its service table.

f. The apparatus must be dusted with a feather brush, and wiped off with a piece of clean soft linen, and entirely freed from dust.

g. If any part of the apparatus is greasy, it must be washed with spirits of wine until the grease is entirely removed, and then polished with prepared rouge and whiting.

h. When this is completed, the covers must be placed over the apparatus.

i. The plate glass of the lantern must be carefully wiped, inside and out, and, should it be found to be necessary, cleaned with Spanish whiting. In case of sea spray it must be washed off with fresh water, and then polished.

j. The curtains of the lantern must then be spread.

k. The service-table, the chandelier, and the interior walls and sides of the dead-lights of the lantern must be dusted, and the stairs swept clean.

l. Having completed these duties, the lamp must be taken down to the storeroom, where it is emptied; the oil it contained measured, to ascertain the quantity consumed during the night, after which, *that oil* must be passed through the filter, if necessary, for future use.

m. The burner of the lamp must be carefully cleaned, within and without.

n. The burned or gummy oil must be removed from the edges of the burner by means of a *scraper*; a *bottle or flexible brush* must be passed through the interior, and the outside must be carefully wiped with a cloth.

o. The body of the lamp must undergo such cleaning as its condition may require.

p. Finally, fill the lamp, renew or trim the wick, and replace the lamp in its apparatus, so that it will be, in every respect, ready for lighting at sunset.

q. Examine carefully into the condition of the spare lamp, which must be kept in the lantern-room of the tower, and be sure it is in perfect order, and ready to be filled for use.

r. An oil can or vessel must be kept filled with filtered oil in the lantern-room, to be used in the spare lamp in case it should be required.

LXXII.—LIGHT-KEEPER'S DUTIES—EVENING ROUTINE.

1. The keeper must go into the lantern every evening, *at or before sunset*, having previously provided himself with a hand lantern and the lighting lamp, or lucerne.

2. If the morning duties have been regularly and properly performed, the following will be the condition of things:

a. The lamp of the apparatus will be in its place and ready to be lighted; its chimney, with a spare lamp, burner, two spare chimneys, and the tool basket containing the various utensils, will be found arranged in the tool closet or store-room; the weights of the revolving machinery in the revolving lights, or those varied by flashes, will be wound up to their greatest height; the driver or master wheel, will be retained by its clutch, and the connecting wheels will be out of gear.

b. Remove the cover from the lamp and burner, and commence light-

ing up at sunset, so that the light may reach its full power by dark, following the directions heretofore given in the execution of that duty.

c. If the apparatus is on a movable chandelier or rollers, place it in the position which it ought to occupy during the night, and for the purpose of keeping it there, stop it with its pin or key.

d. Remove the blinds, fold them up and return them to their closet, (if the apparatus is placed in a permanent lantern.)

e. If the apparatus is placed in a lantern to be hoisted and lowered, it must be hoisted to the top of the scaffold.

f. If the beacon is a revolving or flashing light, the revolving machinery must be put in motion immediately after the light is lighted. To do this, it will only be necessary to put the two cog-wheels in gear, withdraw the clutch which retains the master-wheel, and remove the stop which supports the motive weight.

g. When the temperature is so low as to cause fear that the oil will congeal, it will be necessary to take the following precautions in the evening duties:

1st. *An hour before sunset*, heat the oil until it reaches such a temperature that the hand cannot be held in it; then plunge the burner in it, and let it remain several minutes. The burner must then be returned to its place, and the oil restored to its cistern.

2d. Prepare the heater, and put it in its place.

LXXIII.—NIGHT DUTIES.

1. The light must be visited by the keeper at least every four hours, and oftener, if there should be any reason to fear the light may go out, or that its intensity may become perceptibly diminished, and during stormy weather the keeper must be constant in his attendance upon the light.

2. At each visit the keeper must be provided with a lighting lamp.

3. When the keeper finds that the wicks are carbonized and require to be trimmed or snuffed, he will proceed as follows, according to the description of the lamps under his charge:

a. If it is an ordinary fountain, or hydraulic lamp, he must substitute the spare lamp immediately, after having supplied it with oil, and lighted it outside of the apparatus, resting it on the service-table during the operation.

b. All these operations ought to be executed as rapidly as possible.

c. When a lamp has been removed, and a substitute placed, it must be placed on the service stand or table, the wick trimmed, and put in perfect order for use in case of necessity.

d. The rod lamp, properly lighted and burning brightly, must supply the place of the service lamp while preparing the spare lamp for service.

LXXIV.—METALLIC REFLECTORS.

1. The parabolic and spherical reflectors, when used, must always be carefully dusted with a feather brush, and then wiped with a soft linen, to remove the dust, and then rubbed with a chamois or buffskin which is free from grease or dirt, (provided for this purpose,) until their polish is restored.

2. At the end of every two months, these reflectors must be polished with carefully prepared rouge and whiting, and the precautions indi-

ated in these directions must be strictly observed during this operation. It is the more essential to observe these precautions, as the polish of silver is much more easily affected than that of glass. (See Directions.)

3. Parabolic reflectors will be seldom used except on board of light-vessels.

4. A single one may be used, now and then, for narrow channels requiring arcs of only a few degrees to be lighted.

5. The great art of keeping silvered reflectors clean and in proper condition for reflecting light consists in the daily, patient, and skilful application of manual labor in rubbing their surfaces, beginning at the centre and gradually working outwards with a circular motion of the hand. No damp or wet substance should ever be applied to the silvered parts of metallic reflectors. If the lustre becomes dim, a little prepared rouge, of the finest quality, in the state of an impalpable powder, may be employed on the chamois skin as a polisher. (See directions for preparing rouge powder.) Backs of reflectors and other brass work will be cleaned with rotten stone mixed with oil into a thin paste.

6. If spare metallic reflectors have lain long in store or unused, and have consequently become covered with a thick, dark coating of oxide, rouge powder mixed with oil may first be applied to remove the film of oxide; after that dry rouge powder should be dusted on, and the reflector polished in the usual way with a clean, dry, and soft chamois skin. These precautions are the more essential on account of the danger of scratching the silver, and thereby seriously impairing its reflecting powers.

7. The buff or chamois skins must always be kept in the tin boxes, with close-fitting tops, provided for that purpose, to prevent injury by dampness, dust, and dirt.

LXXV.—MANAGEMENT AND CLEANLINESS—TOWER AND BUILDINGS.

1. Every part of the inside of the tower and buildings must be kept in the most perfect state of cleanliness and neatness; they must be swept and dusted every day, and washed as often as is necessary.

2. The glass of the lantern must be dusted and wiped off every morning, inside and out, and once a week (or oftener, in case of salt spray) it must be washed off outside with fresh water.

LXXVI.—RENEWING GLASS OF BEACON-LIGHTS.

1. As the keepers of beacon-lights may be required to replace a broken pane of glass, some details on the subject are given.

2. Having unscrewed the slats, and removed the pieces of broken glass, the old putty must be carefully cleaned from the frames.

3. Try the new pane of glass, to see that it will not touch any part of the frame, and that there will be a play of about one-twelfth of an inch all around, and particularly around any notches.

4. If any portion of the glass touches its frame, it must be carefully and gradually removed by using a pair of glazier's nippers.

5. A coating of spirits of turpentine must be spread on the frames, and the putty is then applied.

6. Three small blocks of soft wood, of about one-twelfth of an inch in thickness, are to be placed between the lower edge of the glass and the frame, one being set in the middle and the other two at about two inches and a half from the uprights.

7. Without this precaution, the weight of the glass would start the putty, and it would come in contact with the hard surface of the lower border of the frame.

8. Blocks of the same thickness must be placed on the putty throughout the whole length of the uprights, and between the vertical edges of the new pane and the edges of the two adjacent ones, if there be no metal upright between the panes.

9. The slats must then be replaced and the putty applied.

10. The putty must not project beyond the vertical and upper slats, and it is to be bevelled along the lower one, so as to permit the water to run off.

LXXVII.—CLEANING MATERIALS.

LINEN TOWELS.

Pure linen towels, without any mixture of cotton, uniform in texture, and free from knots, &c., *only* must be used in wiping and cleaning lens apparatus, plate glass, and the silvered parts of metallic reflectors.

CHAMOIS SKINS.

1. Two chamois (or buff) skins, which must be kept perfectly free of dust and gritty particles, and to insure this, they must be kept, when not in use, in the boxes with close-fitting covers provided for that purpose, and used to rub the lenses and reflectors, with or without rouge or whiting.

WATCHMAKER'S OIL.

1. This oil is designed exclusively to grease the mechanism of the lamps and the revolving machinery, and to mix with the rouge employed to clean the polished steel of the mechanism.

POLISHING ROUGE.

1. The polishing rouge is especially employed to preserve the polish of the glass pieces of the apparatus, as well as the plate glass of the lantern. For that purpose it must be prepared with the greatest care, as indicated in these directions.

TO PRESERVE THE POLISHING ROUGE, &C.

1. The polishing rouge must be carefully wrapped up and enclosed where dust cannot reach it.

2. If it is not soft and impalpable, it must not be used, inasmuch as, instead of preserving the polish of the glass, it will greatly injure it.

PREPARATION OF THE POLISHING ROUGE.

1. Break up a small quantity of rouge (a few ounces) in clean water, and form a clear mixture with it.

2. Put this mixture into about a pint of clean water, and, after having stirred it up well with a stick, let it rest for a few moments, then pour off the liquid mixture into another vessel carefully, to sepa-

rate the small gritty particles it may contain, and which, by this means, will remain at the bottom of the first vessel.

3. That being done, leave it to settle about half an hour, when pour off the water until the rouge appears on the edge of the vessel.

4. This liquid rouge must be spread lightly, by means of a camel's hair brush or piece of soft linen, over the entire surface of the reflector to be cleaned.

5. When this coat of rouge becomes dry, rub it with a piece of buff-skin until all of it is entirely removed.

6. The rouge, thus prepared, should be entirely consumed, as it will be unfit for future use in cleaning.

WHITING.

1. The whiting, prepared in the same manner, and with the same care as the polishing rouge, serves for the prescribed duties every two months, to preserve the polish of the lenses and the silver-plated reflectors.

2. The whiting used for cleaning the glass of the lantern and silvered portions of the reflectors must be prepared in the same manner as the polishing rouge, but in larger quantities, according to the necessity.

3. Mixed in oil, it is employed to clean the tin utensils. It enters also into the composition of putty for glazing the lantern.

ALCOHOL, OR SPIRITS OF WINE.

1. Spirits of wine is employed to wash the optical pieces of the apparatus, and to remove the grease and discolorations which resist a dry rubbing, as well on those pieces as on the glass of the lantern.

2. To mix with the rouge employed for cleaning the copper utensils and pieces of the mechanism of the lamps, and of the revolving machinery.

ROTTEN STONE.

Directions for preparing and using, for cleaning all brass, composition, and copper connected with the Light-house Service.

Service lamps of all descriptions, rod lamps, ornaments of apparatus, carriage rollers, oil and air cocks, parts of the frame which are not connected with the edge of the catadioptric rings of the apparatus, should be polished with rotten stone in the following manner:

Take about one ounce of rotten stone, pulverize it carefully in a tin pan, then mix it with lamp oil until it becomes a thin paste, then take a piece of coarse woollen cloth, free from dust, dip it in the paste thus prepared, and rub the surface of the article. Those articles which are cylindrical or conical should be rubbed in the direction in which turned, that is parallel to the base, (excepting tubes, which are to be rubbed lengthwise,) also disk-shaped articles, such as top of reservoir, in the direction in which turned; other articles, which have either a horizontal or vertical position, to be rubbed in the direction of their length. Continue rubbing until all stains or marks have disappeared; take a rag and wipe off the greater part of the oil, then take a soft and clean

rag, dip it into the whiting, and rub the article in the same manner until the desired polish is obtained.

The revolving machinery and clock-work of the mechanical lamps are generally lacquered. The last-mentioned parts are cleaned with ronge dissolved in spirits of wine, unless part of the lacquer has disappeared by age or stains, which is frequently the case, and then it has an uncleaned appearance.

In such cases rotten stone may be used as directed above.

TOOLS, IMPLEMENTS, AND VARIOUS ARTICLES USED IN THE SERVICE.

LXXVIII.—TIN AND COPPER WARE.

1. A sucking pump is used for transferring the oil from one vessel to another.

2. Copper vessels should be used exclusively for transporting the oil from one part of the tower to another.

OIL FILTERS.

1. The oil for multiple wick, mechanical light-house lamps, ought always to be filtered by the keeper before it is used.*

2. The filter is composed of two parts: The upper part is the filter, properly so called; the second is a reservoir for the filtered oil, and is fitted with a cock.

3. The filter consists of a plate of tin, pierced with holes, upon which is placed a piece of cloth, and a layer of fine sand about one-tenth of an inch in thickness.

4. Once a month the cloth must be washed with hot water and soap, and the sand passed through boiling water.

5. They must be perfectly dried over a fire before being used again.

6. It is necessary to place this apparatus upon a stand, or small wooden table, of a proper height to allow the oil vessel to stand under the cock.

7. Independently of the ordinary cleaning, the oil filter must be an object of especial care.

8. They must not be replaced until all dampness has been removed. To dry the sand, it must be heated in a pan or other vessel. Sea-sand must never be used for this purpose, even after having been washed in fresh water.

LIGHTING LANTERN.

1. The lighting lantern contains, besides a fixed lamp, two small movable hand-lamps, (lucernes,) which must be used for lighting the lamps of the light-house. In the center of these hand-lamps is a copper screw button, which can be removed to introduce the oil and wick.

* Oil to be used in mechanical (clock-work movement) lamps should, as a general rule, be carefully filtered as prescribed by the Instructions and Directions, for the purpose of removing motes and other things which might arrest the operations of the pumps and prevent the full flow of oil to the burner. Colza and sperm oil should always be filtered before it is put in the reservoir of the lamp. Good clear lard oil is not improved by being filtered. All oil that has passed through a lamp burner should, as a general rule, be filtered for further use.

2. Near the ring, which serves as a handle, is an air tube, upon the orifice of which the thumb is placed to prevent the oil from running out when it is inclined in lighting the wicks of the lamp.

3. This lamp is for the double purpose of giving light to the keeper, and to enable him to light the light-house lamp.

LUCERNE OR LIGHTING LAMP.

1. The *lucerne* is used for lighting the wick of the light-house lamp.

2. Light-house and light-vessel lamps are always to be lighted with the small lighting lamps; matches and paper lighters are not to be used.

HEATER.

1. The heater of the mechanical lamp consists of a small lamp, enclosed in an oblong box, with two nozzles.

2. Upon one of the sides of that box is made, for the passage of the lamp, an opening, which closes hermetically by means of a screw and washer.

3. The heater for fountain lamps is a brass or copper rod bent, with one end resting in the oil in the fountain, and the bent end with a knob on it is over the flame of the lamp.

TOOL BASKET.

1. The tool basket is in the shape of a box, with a handle and a cover, in two parts.

2. It is divided into three compartments. One of them receives a flat box, in which the greasy rags and wick trimmings are placed for the moment. Upon that box are placed the clean rags, towels, and chamois skins, for wiping the glass chimneys, lenses, &c.

3. The second compartment is for the following objects:

a. A *triangular scraper*, to remove the burnt oil remaining on the edges of the burner.

b. A *horsehair bottle brush*, to clean the air tubes of the burner of the service lamp.

c. A pair of *curved scissors*, to snuff the wicks of the lamp.

d. A chimney lifter covered with chamois leather.

e. Chimney tongs, for removing broken glass.

4. Finally, the third compartment is designed to receive—

a. A pair of *straight scissors*, to cut to the proper length the new wicks for the burner.

b. A *calliper* which determines that length.

c. The *mandrils* for putting on wicks. They are of a conical form, except a small part at their base, which is cylindrical, and rebated to receive the wick holder.

d. A trimming hook may be used for removing charred wicks, by passing it up through the inside of the burner.

e. Pickers may also be used for removing excrescences of charred wick called thieves.

f. A foot rule, graduated to inches and tenths, for measuring heights of flames and the distance of the crown of the burner below the focal flame.

DRIPPING PAN.

1. The dripper is a flat, square vessel, having a double bottom.
2. The upper bottom is movable, and pierced with holes; the other has a small tube for pouring off the liquid.
3. It serves also as a dripper for the burner, when it is necessary to remove the service lamp, the lamp feeders, oil measures, &c.

OIL MEASURE AND TEST OF LAMP PUMPS.

1. This measure, of 17.4 cubic inches, or $\frac{6}{10}$ of a pint, (corresponding to a weight of 250 grams, French, in colza oil, a denser fluid than sperm oil,) serves to determine the quantity of oil delivered by the pumps, as explained and prescribed in these Directions. This test must be applied, when the lamp is lighted, every evening.

LAMP STAND.

1. The shape of the lamp stand varies with that of the lamp which it has to support.
2. Each light-house is furnished with two of these articles. One must always be kept on the table of the lantern chamber, the other in the storeroom of the light-house.

LAMP FEEDERS.

1. These lamp-feeders contain a small quantity of oil, and are used for filling the small lamps and hand-lanterns.

ROUGE BOX.

1. The polishing rouge must be carefully kept out of the way of dust. It is therefore enclosed in a double box.
2. Above the smaller box the buffskins designed to rub the pieces of the apparatus and plate-glass with rouge are placed.

WHITING BOX.

For keeping the whiting in.

ROD LAMP.

1. The keepers of the watch must always see for themselves that the rod lamp is placed in the lantern-room ready to be lighted.
2. This lamp must be suspended in the interior of the apparatus, if the service-lamp is extinguished for the purpose of changing it, or should it become necessary to extinguish it for trimming the wicks.
3. The keepers are provided with hand-lanterns for their individual use, and with house-lamps for their dwellings.

OIL GAUGES.

1. Two gauges, $\frac{3}{10}$ of a meter (French measure, or very nearly one foot English) in length, divided into hundredths and thousandths of a

meter, serve to measure the height of the oil contained in the reservoir of the lamp in use, and, consequently, to determine the quantity of that oil, by means of the gauging table of the lamp.

OIL CAN.

1. The oil can is used to fill the reservoir of the lamps. It must be placed every night, filled with oil, on the dresser of the light-house chamber, so that, if required, the reservoir of the spare lamp may be filled without delay.

JACK-SCREWS.

1. The jack-screws, three in number, made of iron or bronze, are specially designed to lift the movable frame of revolving lights.

2. Each jack is formed by a stem or bolt; the extremities of which, threaded in opposite directions, screw into two small movable plates.

3. The stem is increased in size at its center, and pierced with holes, in which a pin is passed to work them, capstan fashion.

SPIRIT LEVELS.

1. All light-houses are furnished with a small straight and a small circular spirit level, which are designed to verify the level of the crown of the burner of the lamp in use.

2. Another level, larger, is furnished to revolving lights, to verify the horizontality of the table upon which the rollers of the carriage move, as also that of the connecting wheel of the revolving machinery.

VALVE OR PISTON MOULD.

1. The mould to form the valve consists of two pieces of cast iron, forming a kind of die, by means of which the best form for the play of the pumps is given to the valves of these pumps.

2. In making and filling new pump leathers for mechanical lamps, the following directions must be followed:

a. Before placing the calfskin in the press, cut a piece $10\frac{1}{2}$ by $3\frac{1}{2}$ inches and steep it in oil for an hour;

b. Then, after cleaning it by a light rub on both sides with waste, press it, in the usual manner, taking care to punch it accurately for the screws of the press;

c. Bring down the press very slowly and equally all over. Not less than one hour should be taken to bring down the press; therefore, the skin should be allowed to remain *one hour* in the press before it is finally placed in the chambers.

PUNCH.

1. This is an instrument of steel, formed for the purpose of making the leather valves used in the pumps of mechanical lamps.

SCISSORS.

1. A pair of straight, and a pair of curved scissors, made of the best

quality cutler's cast steel, for cutting and snuffing wicks, constitute a part of the supplies of every light-house.

TRIANGULAR SCRAPERS.

1. Are designed for cleaning the lamp burners.
2. They are made from triangular files, and are fitted with a tin handle.

GLAZIERS' NIPPERS.

1. These nippers are useful whenever it is required to replace broken glass.
2. To reduce slightly the dimensions of a plate of glass, place the nippers in such a way that the bills may take hold of the edge of the plate, making at the same time a sharp angle with it.
3. By pressing a little upon the handle of the nippers, and turning the hand a little out, the small pieces of glass are cut off.
4. This should be executed slowly, and with great care, removing a very small portion of the glass at a time.

KEY OF THE REVOLVING MACHINERY.

1. This key is made of polished steel, and must be used exclusively for winding up the revolving machinery.
2. Boxwood scale 1 foot, graduated to inches and tenths, for adjusting burners and flames.
3. "Time-marker," *with stop* to second-hand, for revolving lights.

HAMMER, COUPLING, PLIERS, CRANK KEY, FILES, HAND-VICE, FLAT PLIERS, SCREW-DRIVERS, AND SOLDERING IRONS.

1. All of these implements are indispensable, for either mounting or dismounting the mechanical lamps and the revolving machinery, or for making pins when required; and also to execute the little soldering required to the dome of the lantern, and to the utensils of tin, &c.
2. Screw-drivers and keys are used for mounting and dismounting the revolving machinery.
3. After they have been used, they ought to be rubbed with a piece of cloth smeared with tallow or lard, and kept in a dry place.
4. All the keys and screw-drivers which were used in placing the lantern, setting up the illuminating apparatus, the service gallery and its stand, the ladders, the balustrade of the platform, as well as the spare bolts, screws, nuts, &c., should be left at the light-house and preserved with care.
5. Other implements, furnished in accordance with the requirements of the work of placing lanterns and illuminating apparatus, may also be kept at the light-houses, and form a part of their inventories; but they are not indispensable, and do not require to be renewed.

FOCUS INDICATOR.

1. A small instrument, designed by Mr. Faraday, to enable the exact position of the focus of a lens above the burner to be measured. A card will answer the same purpose.

LONG-HANDLE BRUSHES.

1. These are for sweeping the floor and the stairs of the interior of the lanterns.

POPE'S-HEAD.

1. This, which is mounted on a long handle, serves to sweep the platform and the cage of the stairs of the tower.

FEATHER BRUSHES.

1. The feather brush is used to dust the illuminating apparatus, the glass of the lantern, the frame of the rollers, and the cage of the revolving machinery.

2. It is necessary always to dust the optical pieces of the apparatus before wiping them off.

CAMEL'S HAIR BRUSHES.

1. These are used, ordinarily, for putting the polishing rouge upon the surfaces of the glass and silvered reflectors to be cleaned.

SILVER PLATER'S BRUSHES.

1. These brushes have handles, also, but are smaller, and shorter, and stiffer than the preceding.

2. They serve to clean the lamps and utensils, to remove the whitening or the rouge, which it would be difficult otherwise to take out from the cavities and re-entering angles.

3. They are particularly designed for those parts of the revolving machinery made of copper or brass.

4. Paint brushes for general use at the station.

5. Coal-tar brushes for putting coal tar on iron work.

HAND BRUSHES.

1. The hand brush, or counter brush, is of a half-round shape, and has a handle ten or fifteen inches long. It is used for the lantern frame, interior walls, the four or five last steps of the stairs, &c., instead of the ordinary broom, whose long handle might cause an accident.

SASH BRUSHES.

1. Are designed to paint the iron of the lantern and the illuminating apparatus; and one of them ought to be kept to spread the rouge upon the surfaces of the optical pieces and the plate glass of the lantern.

FLEXIBLE OR BOTTLE BRUSHES.

1. The bottle-brushes are made of horsehair, mounted upon a wire stem, and are used for cleaning chimneys and lamp-burners.

CALFSKIN.

1. One calfskin, to make valves and washers for mechanical lamps.

CLEANING OF THE INSTRUMENTS.

1. All the tin utensils used in the light-house service must be rubbed with whiting twice a year, or oftener, if necessary.

MANAGEMENT OF LENS APPARATUS AND LAMPS.

LXXIX.—ORDERS OF FRESNEL LENS APPARATUS.

1. The lens, or Fresnel, illuminating apparatus is divided into three principal and four minor orders, according to the size and number of wicks in the burners.

They are denominated—

- a.* First order, with a lamp of four concentric wicks;
- b.* Second order, with a lamp of three concentric wicks;
- c.* Third order, (large,) with a lamp of two concentric wicks;
- d.* The third order, (small,) with two wicks.

2. The three minor orders are—

- Fourth order, with one wick, or two concentric wicks;
- Fifth order, with one wick;
- Sixth order, with one wick; and steamer's lens, (large.)
- Seventh, steamer's (small) lens with one wick.

OPTICAL PARTS AND FRAME.

1. The optical parts of this apparatus are composed of glass lens or dioptric panels, and of glass catadioptric panels.

2. These pieces are united and assembled together by means of a metallic frame, having a cast-iron column for a support.

| | Ft. | In. |
|--|-----|--------|
| <i>a.</i> The interior diameter of a first-order apparatus is, say . . . | 6 | 0.44 |
| <i>b.</i> The interior diameter of a second-order apparatus is, say . . . | 4 | 7.12 |
| <i>c.</i> The interior diameter of a third-order (large) apparatus is, say | 3 | 3.371 |
| <i>d.</i> The interior diameter of a third-order (small) apparatus is, say | 2 | 5.53 |
| <i>e.</i> The interior diameter of a third-order (small) apparatus (0.70 <i>m.</i>) is, say | 2 | 3.56 |
| <i>f.</i> The interior diameter of a fourth-order apparatus is, say . . . | 1 | 7.685 |
| <i>g.</i> The interior diameter of a fifth-order apparatus is, say . . . | 1 | 2.764 |
| <i>h.</i> The interior diameter of a sixth-order apparatus is, say . . . | 0 | 11.811 |
| <i>i.</i> The interior diameter of a steamer's lens, large | | 11.811 |
| <i>j.</i> The interior diameter of a steamer's lens, small | | 7.874 |
| <i>k.</i> Range-lights apparatus of small arcs, having an intensity=500 candle lamp-burners. | | |

ADJUSTMENT OF THE DIOPTRIC AND CATADIOPTRIC PANELS.

1. The dioptric and catadioptric panels of the lights are solidly fixed in their metallic frames with screws and bolts, and cannot be displaced or put out of adjustment except by extraordinary carelessness or accidents, which it is unnecessary to speak of here.

2. Should any of the putty of the rings or prisms of the apparatus be started, it must immediately be replaced with new putty.

3. Once each month the lenses and prisms must be washed with spirits of wine.

4. The entire apparatus must be thoroughly cleaned once a year (in

the month of July) with polishing rouge, and in the way set forth in these directions, in addition to the *daily and weekly*, cleanings required.

LAMPS.

1. Each lens light in the three largest orders is illuminated by a mechanical, moderator, pneumatic, or hydraulic lamp, with the burners so placed that the centre of the flame when at its normal height will be in the common focus of the apparatus.

2. All these lamps are furnished with multiple wicks, varying in size and number according to the order of the apparatus.

3. The several kinds of lamps employed differ only in the mechanical contrivances, which, in all, have the same object, viz., to supply oil at a given rate of consumption; and whose moving power is a weight working inside the hollow support, a spiral spring, or a float for regulating the flow of oil to the burner.—(See plates of mechanical, moderator, and hydraulic lamps.)

LXXX.—FRENCH MECHANICAL LAMPS.

The lamps used in the French light-house service are:

1. The Lepaute lamp;
2. The Wagner lamp;
3. The clock-work movement lamp; and,
4. The moderator lamp, for colza or sperm oil.—(See descriptions and plates.)

The French mechanical lamps comprehend five principal parts, viz:

- a. The oil cistern, or reservoir;
- b. The weight and gearing, or machinery;
- c. The pumps;
- d. The burner; and
- e. The glass chimney, with its regulator or damper.

THE OIL CISTERN.

1. The *reservoir, or cistern*, is a cylindric vessel of copper or tin, placed in the middle of the mounting of the lamp.

2. It should be large enough to contain double the quantity of oil required for fifteen or sixteen hours' burning.

THE WEIGHT.

1. The *weight*, which gives motion to the machinery, is usually hooked to a movable pulley that slips along the winding-up cord, one of whose ends is attached to the barrel; and the other, after passing through the pulley, is brought upward again and made fast to some convenient point in the base of the lamp.

2. The object of this arrangement is only to double the time that the weight will run without increasing its fall. Of course, double the weight is required that would be necessary if it were attached to the end of the cord without any pulley.

3. The motive weight, in well-made and well-kept machinery, will not exceed—

- a. For lamps of first order, seventy-seven pounds;
- b. For lamps of second order, sixty-six pounds;
- c. For lamps of third order, forty-four pounds.

NECESSARY PRECAUTIONS TO BE OBSERVED IN WINDING UP THE MACHINERY WHILE THE LAMP IS BURNING.

1. Whenever it becomes necessary during the night to wind up the clock weight of the lamp in use, *after every third turn of the crank, press it back for a moment, in the opposite direction, to allow the pumps to force the oil up and prevent the flames from increasing too much and smoking the chimney.*

CLEANING.

1. All the brass-work of the service lamp must be cleaned *every eight days*, with rouge dissolved in spirits of wine.

2. When a lamp is withdrawn from the apparatus to be placed in store, *its wicks must be removed, the lamp emptied and drained, and cleaned outwardly with rouge.**

3. It is cleaned inside by rinsing it several times with strong soap-suds, or a weak lye of wood ashes, but it must be made perfectly clean before filling it for use.

THE MACHINERY OF MECHANICAL LAMPS.

1. The machinery, is in general, contrived to turn a vertical arbor, which, by cranks and connecting rods, communicates a reciprocating motion to the piston-rods of the pumps.

2. The details of arrangements vary according to the ideas of different makers, as will be seen by the following descriptions of the clock-work of the mechanical lamps chiefly in use, viz:

CLOCK-WORK OR CARCEL LAMP.

a. The *clock-work* or *Carcel lamp* is composed of a barrel carrying the driver, two horizontal arbors, the first of which carries the middle, and the second a bevel-wheel; a vertical arbor, provided with another bevel-wheel at its lower extremity, which traverses the oil cistern and puts the feed pumps in motion by means of the four small wheels which gear into each other.

b. The regulator of this machine is a simple fly.

THE LEPAUTE LAMP.

1. The *Lepaute lamp* is composed of a barrel, carrying a crown-wheel, fitted upon its two faces, with roller pins, which form the escapement upon four points of bent levers.

2. These levers communicate, by cranks and connecting rods, with two arbors, which traverse the oil cistern, and which, by means of two fixed levers at their upper extremity, put the four feed pumps in motion.

3. This machinery is regulated by a small orifice, pierced in a diaphragm, placed in the upper part of the pumps, through which the oil passes to reach the burner, for a regulator. In some lamps of this description a small screw, terminated by a point, is added to the pumps, which, penetrating the regulator orifice, *allows the flow of the oil to be regulated at will, by turning the screw.*

* Pulverized rotten stone, mixed with lamp oil until it reaches a consistency of a thin paste, may be used in cleaning the outside brass work of lamps, and the metallic frames of lens apparatus.

THE WAGNER LAMP.

1. The *Wagner lamp* is composed of a barrel, carrying the driver and two horizontal arbors, fitted with the ordinary clock-work; the second of which transmits the motion to two vertical arbors by means of cranks and connecting rods.

2. These last arbors traverse the oil cistern, and put the four feed pumps in play by means of two fixed levers at their upper extremity.

3. The regulator is, *as in the case of the first lamp*, a simple fly.

4. This lamp has, besides, *as in the case of the Lepaute lamp*, an apparatus designed to regulate at will the flow of the oil to the burner.

5. It consists of a small screw placed upon the pumps, which, *being tightened, reduces the opening left for the passage of oil.*

THE PUMPS.

1. The pumps communicate with the reservoir of oil by means of a feed pipe fitted at its lower extremity with a small filter.

2. The pistons, (three or four in number,) are formed of plungers of calf skin, and the valves are simple washers of the same leather.

CONSUMPTION OF OIL IN MECHANICAL LAMPS.

1. The consumption of oil in a mechanical lamp, producing its full effect, is, per hour, nearly, with sperm and colza oil—

a. In a lamp of the first order, about 760 gallons per annum.

b. In a lamp of the second order, about 503 gallons per annum.

c. In a lamp of the third order, (large,) about 179 gallons per annum.

2. To enable the flame to produce its full effect, and at the same time keep the crown of the burner sufficiently cool, the pumps should deliver nearly four times as much oil per hour as the lamp consumes, viz:

a. For the first order, about two quarts one pint.

b. For the second order, about one quart one and one-half pint.

c. For third order, about one and one-fourth pint.

3. The excess of oil overflows the burner, and falls back into the cistern.

TO FILL THE RESERVOIR AND WIND UP THE WEIGHT.

1. Having supplied the burner, pour into the reservoir about one and a half times the quantity of oil necessary for consumption during the night; then wind up the clock-weight of the machinery with its crank or key.

2. After the lapse of a few moments, the oil, which is sucked and forced up by the pumps, will have saturated the wicks, and the remainder will pass over the crown of the burner into the dripper, and after the light is fairly burning, through the alarm-bell ("carrillon.")

TEST OF THE WORK OF THE PUMPS.

1. To ascertain if the oil is raised in sufficient quantity by the pumps, or by hydraulic pressure in hydraulic lamps, a measure of the capacity of 17.4 cubic inches, or $\frac{6}{10}$ of a pint, (250 grammes,) is placed under the discharge pipe of the burner, and the time required to fill it is noted.

2. After what has been said, the time necessary to fill this vessel before lighting the lamp ought to be:

a. Five minutes for a lamp of the first order;

- b. Seven and a half minutes for a lamp of the second order; and say
- e. Twenty minutes for a lamp of the third order.*

LXXXI.—ATTENDANCE ON MECHANICAL LAMPS.

PERIODICAL CHANGES OF THE SERVICE LAMPS.

1. *After fifteen days of continued service*, the "service" lamp of the apparatus should be changed for one of the two spare ones; and this alternation *must take place regularly between the three lamps, so that all three may be kept in proper condition for service.*

2. This change should be made *in the morning*, and the oil should be pumped through the new lamp (unlighted) to see that it works well.

TO CLEAN THE MECHANICAL LAMP AFTER FIFTEEN DAYS' SERVICE.

1. The lamp having been taken from the apparatus, it should be examined and cleaned with care.

a. Observe to *take off the pumps at once, and remove from them all remaining oil*, which, becoming old, interferes with the play of the valves.

2. The feed tubes should *be unscrewed* and its filter cleaned.

3. The lamp, *being readjusted and covered*, should be put away in one of the closets of the lantern room.

TO USE AND PRESERVE THE MULTIPLE WICK BURNERS.

1. Of the six burners belonging to the three mechanical lamps of a lens light, *one must be always mounted and fitted to the lamp of the apparatus*; another fitted with dry wicks must be kept as a spare one in one of the closets of the lantern room.

2. The four others, *without wicks, well cleaned, perfectly dry, and having their racks slightly greased with unsalted lard or good oil*, must be kept wrapped up in a dry closet, and they should not be used except when one of the two first requires repairs.

3. The spare burners must be examined from time to time, and cleaned when necessary.

4. It must be seen that their racks play freely.

5. They must then be wiped and again greased.

THE ORDINARY MANAGEMENT OF MECHANICAL LAMPS.

1. To keep the machinery of the lamps in good condition, *care should be taken that, from time to time, a little clockmakers' oil be applied to the pivots of the several movable pieces, as also to the escapement pivots of the Lepaute lamp.*

2. *This oil should be applied more frequently to the pivots of the fly, to those of the driving wheel, and to the endless screw of lamps with clock-work movement, than to any of the other pieces.*

3. Care must be taken, however, to apply this oil *in very small quantities only*, and after having carefully removed, with a clean piece of linen attached to a stick, *all of the old oil adhering to the several parts of the machinery.*

* This measure of 250 grammes capacity must be furnished to every light-house of and above the third order, and the flow of oil must be tested by it every day after the lamp has been lighted, so as to properly regulate the flow of oil.

4. The mechanism of mechanical lamps must be kept at all times scrupulously clean, and all the working parts carefully and regularly lubricated with oil.

DISMOUNTING AND COMPLETE CLEANING OF THE MECHANICAL LAMPS.

1. Each mechanical lamp must be dismantled and completely cleaned as often as may be necessary, *and at least once every year.*

2. To clean *the brass pieces of the machinery*, they must be entirely covered with rouge or whiting, mixed with spirits of wine, and then rubbed with a silver-plater's brush until they are handsomely polished.

3. *The steel pieces must be cleaned with rouge, mixed with a little clock-maker's oil.*

4. Before the mechanism is replaced, the holes of the pivots of the wheels, as also the threads of the screws, should be cleaned with a small stick of soft wood, *and care must be taken that every particle of rouge and whiting employed in the cleaning is removed.*

DERANGEMENT OF THE MECHANISM OF THE MECHANICAL LAMPS, AND THE MEANS FOR REMEDYING IT.

1. When a mechanical lamp, after having performed for some time, *ceases to act well*, the keeper must search for the cause of this disturbance, so that he may remedy it as far as possible.

2. *To facilitate this search*, the principal causes which may prevent the regular performance or injure the effect of the different kinds of lamps, are enumerated as follows :

IRREGULAR FLOW OF THE OIL.

a. When the oil flows irregularly, the flames fall and rise unsteadily, and cannot be maintained at a constant height.

b. *In the clock-work movement lamps*, this defect may arise from imperfect gearing of the wheels which keep the pistons in motion.

c. *This can be remedied by restoring the gearing to the positions indicated by the maker's marks.*

d. *In lamps of the new model, (Lepaute,) in which the pumps are put in play by two cranks*, the defect cannot arise in this way.

e. In these lamps, the irregular flow of the oil may arise from a misplacement of the cranks which transmit the motion to the vertical arbors from a simple loosening of the screws which sustain the escapement levers, or from wear in the escapement.

f. *In the first case*, it will be necessary to restore the cranks to the places indicated by the marks, *in the second case*, to tighten the loosened screws, and, *in the third case*, the lamp must be sent to the lampist to be repaired.

g. As for the *Wagner lamps*, they do not appear to be liable to this defect, except in consequence of the wearing of the pieces after long-continued use.

THE PLAY OF A VALVE ARRESTED.

1. It may happen that one of the valves may cease to perform, owing to the derangement of the steel wire, or by sticking to the metallic cloth, (if it happen to a Wagner lamp,) which it will be sufficient to restore to its place.

2. Whenever a mechanical lamp remains long out of use, and the body of the pumps has not been thoroughly cleaned, the valves lose their pliability by the viscosity which the coat of oil adhering to their surfaces gains by age.

3. It is necessary to clean valves found in this condition, by washing them in warm oil, or to replace them by new ones, made by the instrument furnished for that purpose.

4. Whenever one of these valves becomes broken, the flow of oil will be no longer regular, nor in sufficient quantity. It is discerned immediately by the waste of oil which ensues, and it is remedied by replacing the valve by a new leather; the proper form of which is given by means of a cast-iron mould.

5. The renewal of the valves in mechanical lamps is an operation in which the keepers of lens lights ought to be practiced. It is necessary in performing it to take care not to stretch too tightly the calfskin in the body of the pumps; for then the movement of the pistons will sometimes be stopped, and there will be an irregular flow of the oil.

6. There will be the same irregularity of the movements if the valves are too loose.

7. If a valve becomes broken in the course of the night service, and the flame cannot be sustained at least at two-thirds of the prescribed height, it will be necessary to change the lamp.

FEED TUBE OBSTRUCTED.

1. If the renewal of the service lamp every fifteen days be neglected, or the filtering of the oil before it is poured into the cistern, or, finally, the cleaning of the metallic cloth of the feed tube at least once a week, it may happen that the small holes of that cloth may be found to be obstructed so as to intercept, or at least to interfere greatly with the flow of the oil.

2. To prevent, in such a case, the necessity for changing the lamp during the night, the difficulty may perhaps be obviated by increasing the motive weight, or by opening the arms of the fly in lamps provided with that description of regulator.

3. Whenever the burner of a mechanical lamp is not supplied with a sufficient quantity of oil, the wicks become carbonized; the flames reddens, rises, and smokes; and if the flow of the oil ceases entirely, the crown of the burner, being no longer protected by the oil, melts, or at least becomes unsoldered.

4. If, on the contrary, the oil flows in excess, it hinders the development of the flames.

5. The first kind of irregularity may arise either from the obstruction of the filter of the feed tube, (which may have been neglected in cleaning,) or from the obstruction of the orifice of the diaphragm of the body of the pumps. In both cases it will be necessary immediately to increase the flow of the oil to the burner by turning off the screw of the pumps, the point of which partially closes the orifice of the diaphragm, if it happens to a lamp provided with that mechanism; and if it happens to a lamp not so provided, by pressing slightly with the key on the weight barrel in the opposite direction to winding up.

6. The second kind of irregularity (an excess of oil) may be remedied in the Lepaute lamp by turning the regulating screw (when there is one) so as to lessen the orifice; in the clock-work movement and Wagner lamps, by opening the wings of the fly; and in all, by diminishing the motive weight.

LAMPS AND BURNERS USED IN THE FRENCH LIGHT-HOUSE SERVICE.

First order, 4 wicks, maximum diameter of flame in full development, 90 millimeters = 3.54 inches. Maximum height of flame above top of burner, 100 millimeters = 3.94 inches.

Second order, 3 wicks, maximum diameter of flame in full development, 75 millimeters = 2.95 inches. Maximum height of flame above the top of the burner, 80 millimeters = 3.15 inches.

Third order, double wick, (large model,) maximum diameter of flame in full development, 45 millimeters = 1.77 inch. Maximum height of flame above the top of the burner, 70 millimeters = 2.76 inches.

Third order, double wick, (small model,) maximum diameter of flame in full development, 38 millimeters = 1.50 inch. Maximum height of flame above the top of the burner, 65 millimeters = 2.56 inches.

Fourth order, single wick, maximum diameter of flame in full development, 30 millimeters = 1.18 inch. Maximum height of flame above the top of the burner, 45 millimeters = 1.77 inch.

Fifth order, single wick, maximum diameter of flame in full development, 27 millimeters = 1.06 inch. Maximum height of flame above the top of the burner, 37 millimeters = 1.45 inch.

Sixth order the same as the fifth.

PLATES.

The figures 1, 2, 3, 4, 5, 6, 7, and 8 represent the different kinds of French lamp burners, (adapted to the different orders and sizes of lenses manufactured,) and the flames which they produce. They are drawn to half actual size. The burners for apparatus of the third order (small model) and the fourth are not represented. Figure 1 shows the plan of the first-order lamp-burner, as seen from above it, and figure 2 represents on one side the elevation, and on the other the section taken along the line A B of the plan.

Figures 3 and 4, 5 and 6, 7 and 8, give, respectively, the plan, elevation, and the section of the burners, and the flames of second, third, and of the fourth order constant-level lamp. These plates show exactly all that enters into the composition of a lamp burner, but without details, which the instructions explain fully.

LXXXII.—LAMPS WITHOUT CLOCK MACHINERY.

1. Mention has been made of the employment of other lamps than the mechanical ones.

2. The principal kinds of these others will be now spoken of, and instructions given for their management.

3. Of course, the setting and adjusting of any and all kinds of lamps within the lens is the same as prescribed for a mechanical lamp.

4. It is only in their description and subsequent management that there is a difference, as follows:

HYDRAULIC LAMP.

a. This lamp is composed of a reservoir of the proper capacity to hold the requisite quantity of oil for use during one night; a supply cistern, whose top is flush with the bottom of the reservoir; and a burner, whose crown is flush with the bottom of the cistern.

b. From the bottom of the reservoir a tube is led into the side of the supply cistern, and in the end of this tube, in the cistern, is a movable stop, to which is attached, *by a curved piece of metal*, a hollow metallic ball, which serves, by closing or opening the tube, as the oil in the cistern rises or falls, to regulate the flow of oil in the cistern, and, consequently, to the burner.

c. The oil is conducted from the supply cistern through a tube from the bottom of the cistern, leading at first downward, and then horizontally to the burner, thence up to and through the several branch tubes connected with the several concentric wicks.

4. The surplus, or overflow of oil, passes off, *as in the case of the mechanical lamp, into the overflow cistern.*

MANAGEMENT OF THE HYDRAULIC LAMP.

1. The precautions to be taken in the management of this lamp are, *to draw off the oil in the morning from the overflow cistern, and either put it into the reservoir or make some other proper disposition of it; and, half an hour before lighting, lower the regulating ball into the supply cistern, to allow the oil to flow and thoroughly saturate the wicks.*

2. The burner is in every respect similar to that of the *mechanical lamp*, and is managed in the same way, so far as the wicks are concerned.

3. In putting out the light, *stop the flow of oil by raising the regulating balance ball*, and extinguish the light by turning down the wicks in succession, commencing with the outer one.

4. Replenish the upper reservoir with oil.

5. In addition to the usual precautions to be taken with multiple wick-burners, in cleaning, supplying with wicks, &c., *the union joints must be carefully examined*, to see that they are secure and in good order.

6. The internal parts of the lamp and cisterns require to be *thoroughly cleaned about once in six months*. To execute this duty in an effectual manner, it will be necessary to unscrew all the union joints, and have the entire interior cleaned with the flexible brushes provided for the purpose.

7. The oil in the overflow chamber must be drawn off, and in lowering the regulating ball, care must be taken to place it so *that it will preserve its previous level.*

8. *This lamp can only be used where but a part of the horizon is required to be illuminated.*

HYDRAULIC OR VALVE LAMP—DESCRIPTION OF THE LAMP.

1. The hydraulic lamp may be used *in all orders of lenses.*

2. For the first three orders, it consists of a reservoir at the top of the lens; another reservoir to contain the oil which overflows the burner; and when it is first put into the lamp, a pump to raise the oil to the upper reservoir and the burner.

3. The upper reservoir is cylindrical or conical. It is pierced by a cylindrical hole through its center, the diameter of which depends upon the order of the lens, increasing with the order. Through this hole a sheet-iron chimney passes down to the glass chimney. In the lower part of this is a damper like that in mechanical lamps.

4. Two brass pipes connect the upper reservoir with the lower. One of these leads from the pump (which is connected with the lower reser-

voir) to the top of the upper reservoir, and is used to fill that reservoir with the assistance of the pump. The other leads from the upper reservoir to the burner, and has in its lower part a *throttle-valve*, which is regulated by the flow of the oil from the burner.

5. The capacity of the upper reservoir, and pipes leading to and from it, is a little greater than that of the lower reservoir.

6. In the upper cover of the upper reservoir is a register which surrounds the sheet-iron chimney and is concentric with it.

7. *When the register is open*, the heated air passes through between the chimney and the reservoir, producing but little effect upon the temperature of the oil.

8. *When it is closed*, the heated air is obstructed and the oil is heated by it, so that in cold weather it is kept fluid enough to flow through the pipes.

9. The upper reservoir is fastened to the framework of the lens by three iron dogs. These can be raised or lowered, as may be found necessary, by screws.

10. The pipes are secured in their places by screw couplings.

TOOLS.

1. A small box of tools, containing the necessary files, screw-drivers, pincers, and hammer, is furnished with the lamp.

2. By these tools the lamp can be mounted or dismounted by the light-keeper.

GENERAL REMARKS.

1. The rules for the manipulation of the hydraulic lamp are the same as those for the mechanical lamps. (See drawings, descriptions, &c., of lamps.)

2. The whole lamp, *including the upper reservoir*, must be dismounted and thoroughly cleaned with lye or strong soap-suds, *every two weeks*.

3. In dismounting the reservoir, the greatest care must be taken to prevent any injury to the apparatus, *and the keeper and the assistants must all be present while the dismounting is going on*.

4. If the light should burn badly during any night, the whole lamp must be thoroughly cleaned during the next day, *and must be lighted and kept burning for at least one hour before the time of lighting up for the night*, to test its action.

OPERATIONS OF THE LAMP.

1. To place this lamp in operation, *the lower reservoir is filled with filtered oil*.

2. The cock of the pipe leading from the upper reservoir to the burner is *stopped*.

3. The oil in the lower reservoir is then raised into the upper by means of the pump and the other pipe.

4. The cock of the burner pipe is *then entirely opened*, and the oil flows from the upper reservoir into the burner, overflows the burner, flows into the cup of the throttle-valve lever, which valve it keeps partially closed by weighing the cup down, and after filling the cup flows into the lower reservoir.

5. So long as the oil runs freely from the upper reservoir, it will overflow the burner and give a supply to the flame, *the amount of which depends upon the stop-cock and the throttle-valve*, by which, therefore, it can be regulated.

6. Should the supply be too much diminished, by impurities in the oil, the cup of the throttle-valve lever will be emptied, the end of the lever will rise, and the throttle-valve will be opened, so that the flow will be increased.

7. *The oil must be pumped back to the upper reservoir when it has nearly run out.*

8. A little practice will inform the keeper at what time he ought to pump.

9. The burner differs in no respect from that of the ordinary mechanical lamp.

10. All of the tools mentioned in the preceding articles, except those for cutting piston and valve leathers, are furnished with the apparatus in which this lamp is used.

THE PNEUMATIC LAMP.

This lamp is composed of a reservoir, which is filled with oil.

a. A chamber for overflow of oil from the lamp.

b. A supply cistern filled with oil, and an air chamber.

c. A tube, fitted with a stop-cock, passes from the bottom of the reservoir through the overflow chamber and supply cistern into the air chamber, around which is placed a receiver for the oil, with its top near the top of the air chamber, over which the oil passes into the air chamber.

d. A tube from the top of the air chamber, on the opposite end from the one the tube from the reservoir enters, passes up into the supply chamber.

e. The main stem or tube leading to the burner passes from a cock at the centre of the bottom of the supply cistern up through the supply cistern and reservoir to the branches leading to the different wick-holders of the burners.

f. The pressure of the oil from the reservoir into the air chamber will force the air into the supply cistern, and cause the oil to flow to the burner, so long as there is any oil in the reservoir.

CONSTANT-LEVEL LAMPS.

Double-wick constant-level lamps.—The application of double wicks to the ordinary Argand lamps has been successfully tested, but are seldom used.

a. The only difference in the management will be to develop the flame more slowly during the first hour of combustion than in the single wick lamps, and to use the damper judiciously in regulating the height of the flame.

b. The consumption of oil of a double-wick constant-level or fountain lamp is about $7\frac{3}{4}$ cubic inches, or $\frac{1}{4}$ of a pint nearly per hour, and 146 gallons a year.

c. Should a burner be injured by use or accident, it must be replaced immediately by one of the spare burners.

d. This can easily be done by unscrewing the joint.

e. *Before placing the new burner, the junction must be fitted with a fresh leather washer.*

LEVEL OF THE OIL.

a. The level of the oil in the new burner must be attended to. It must be maintained at about $\frac{1}{2}$ of an inch below the upper edge.

b. Should this level be too high, the oil would overflow; if, on the contrary, it be too low, the flame will be too near the burner, the edges of which would soon be burned.

c. When the level of the oil is too high, a small plate of tin must be soldered over the notch on the small cylinder at the bottom of the reservoir of the lamp; then, with a file, a new notch is made to the cylinder, care being taken not to make it as low as the first.

d. When the level is too low, the notch is enlarged in the manner above stated.

e. At the end of every fifteen days the service lamp of all lighting apparatus must be removed for a thorough overhauling and cleaning, and replaced by one of the spare lamps.

HYDRAULIC LAMP FOR FOURTH, FIFTH, AND SIXTH ORDER LIGHTS.

This lamp was designed by Captain William B. Franklin, United States Corps Topographical Engineers, and Engineer Secretary of the Light-house Board.

It consists of three principal parts, viz:

1st. The reservoir* *S*, with supply tube *P* attached, resting on the upper ring of lens. The reservoir should be perfectly air tight.

2d. The burner, with reception tube or oil chamber *R*.

3d. The bracket *f*, with a drip-cup fastened to bottom ring of the lens. *d* is an air chamber opening into the reception tube.

DIRECTIONS FOR USE.

a. The bracket *f* must be fitted so that the upper level, or edge of the burner, when attached, shall be 0.87 of an inch below the focal plane, and so that the centre of the burner shall be directly under the crossing of the threads which mark the focal plane. (Some lenses are provided with two sets of threads—the lower ones in this case mark the height and position of the burner.)

b. The burner is attached to the bracket by inserting the pin *e*, on the ring of the burner, into the socket of the bracket.

c. When the burner is changed it is lifted up, there being sufficient play allowed for the purpose in the cup at the upper end of the reception tube.

d. In filling the lamp, the outside cylinder *B*, of the cock, must be closed; then remove the screw plug *n*, without disturbing the lamp from its position; then pour the oil into the opening of the cup *m* until it is perfectly full; then screw the plug, which is provided with a leather washer, in its place; then fill the cup *m* with oil to prevent the air from getting into the reservoir, which would cause the overflow of oil.

e. The lamp must be handled by the body of the reservoir.

f. Before lighting the service lamp, the outside cylinder, *B*, of the cock, must be reversed to the other stop pin, thereby opening the valve hole *b*, and permitting the oil to flow until it finds its level in the burner,

* See drawings.

which level will be the same as that of the upper line of the valve hole, $\frac{3}{8}$ of an inch below the upper edge of the burner, for sperm oil; for colza and lard oil, $\frac{1}{4}$ of an inch. The cock can be detached by unsoldering it, and raised or lowered as may be required; *but a perfectly tight joint must be made when readjusted.*

g. Let the oil flow into the burner for about half an hour before lighting the lamp.

h. With each lamp, as above described, is sent one extra reservoir; two extra burners, one drip cup; one copper pipe with damper and key to be used when the oil does not get sufficiently heated.

i. By reducing the size throughout, this lamp is also adapted to fifth and sixth order lenses.

DESCRIPTION OF HYDRAULIC LAMP.

This lamp was designed by Lieutenant George G. Meade, United States Corps Topographical Engineers, and erected by him at Sand Key Light-house, Florida.

1. It was intended to take the place of the French lamps of the Carcel pattern, and do away with the pumps and clock-work machinery.

2. This is effected by substituting for the pumps a reservoir in the dome of the lantern, and thus causing the oil to rise through the burners to the wicks, by the fall and pressure due to the height of the reservoir above the level of the wicks.

3. It is this principle which has induced the name of hydraulic lamp.

4. The lamp consists of the following parts, viz:*

I. Burner.

II. Overflow reservoir.

III. Supply reservoir.

IV. Connecting pipes.

5. *Burners.*—These are of the same pattern exactly, and the diameters of those sent with the mechanical lamps of the different orders from Paris.

6. *Overflow reservoir.*—This is a cylinder of block tin, or brass, in an iron frame, with three foot rings, so adjusted that it can be placed on the pillars designed for the French lamps. It is of such dimensions as to have a capacity sufficient to hold the overflow from the burners, or three times the consumption of the lamps for the longest night of the year. It will, therefore, of course, vary according to the order of the apparatus and the latitude of the station.

a. On top of the cylinder is an iron frame to receive the burner, with the usual ring and clamp screw.

b. There is also attached to the top a brass box, having a projecting screw in the middle to receive the tube of the burner, and underneath a pipe, which passes through the reservoir to the service table beneath, with a stop-cock in it, and a screw end.

c. There is also in this brass box a small compartment, (directly under the burner tube,) with an orifice, through which the oil rises from the box to the burner; and this orifice is so arranged that by means of a screw-pin it can be closed or opened at will, thus permitting the delivery of the oil to be regulated.

* For drawings see Light-house Board portfolio, Nos. 16, 14 I, 14 II, 14 III, 14 IV, and 14 V, and drawings s.v.o. size in descriptions of lamps, and directions for their use, at end of description of the lamp.

d. There are strainers in this box, between the orifice and the pipe from below.

e. This box and pipe, with its projection, are permanently attached to the cylinder, so that by disconnecting the screw joint below, the reservoir can be removed, and another lamp used if desired.

f. The top of the brass box is screwed on by two screws. On being taken off it can be readily cleaned.

g. The whole reservoir is made plain and substantial, the pipe being a stout brass tube of $\frac{3}{8}$ inch diameter. Galvanized iron of $\frac{1}{8}$ inch is an excellent material for the cylinder, being stiff and very durable.

7. *Supply reservoir.*—This is made either of block tin or galvanized iron, and of a capacity a little over four times the consumption of the longest night.

a. It is placed in some convenient position in the dome of the lantern, above the apparatus, and has a discharge pipe, with a stop-cock and screw-joint end, the same as in the overflow reservoir.

b. Where the oil passes into this pipe there is placed a strainer.

c. At Sand Key this reservoir is a box, 4 by 6 inches, placed half way around the eave-ring of the lantern, and sustained by brackets from that ring. It might be placed around the iron smoke pipe, which, in northern latitudes, where it is necessary to heat the oil, would be a more convenient position, and a tube to convey the heated air from the chimney would be avoided.

8. *Connecting pipe.*—This is made of the same size and material as the pipes and reservoirs above described, with screw-joint ends to unite with them.

a. It passes inside of the apparatus, from the supply reservoir, and leads down an upright of the lens frame to the service-table, and along that till it joins the pipe of overflow reservoir. Of course its length and shape will depend on the size and character of the apparatus.

b. There is no difficulty in attaching it to any apparatus which has any of the parts fixed.

c. Should the apparatus be like the one erected at Cape Hatteras, where the whole frame-work carrying the optical parts revolves, it would be necessary to pass the pipe through the *fixed cylinder* at top, around which the upper friction rollers revolve, and let it descend unsupported to the service-table, in which case the pipe should be proportionably stout. In this case only would it obstruct any light, and then so insignificant a portion as to be of no consideration, and in most cases there are azimuths where the light is not required.

d. In cold climates where it is necessary to discharge the oil from this pipe during the day, a cock must be provided for this purpose in its lower joints.

WATCH-ROOM OIL-TANK—HYDRAULIC LAMP.

1. This is an addition, though not a necessary part of the lamp. It is made of $\frac{3}{16}$ inch galvanized iron, and of a capacity sufficient for a month's supply for the lamp.

a. It has a pump attached to it, and a pipe leading up one of the lantern astragals to the supply reservoir, which can thus be readily filled in a few minutes, without the necessity of the keeper's climbing up in the lantern, always dangerous to the safety of the apparatus.

b. In northern latitudes, where there are stoves in the watch-room, it

is presumed the oil in this tank could be kept sufficiently fluid to permit its use.

c. It will be seen that the parts of the above-described lamp are exceedingly simple, and that they reduce the duty of the keeper in its service to merely attending to his burners, and shutting off or letting on his oil, regulating the flow by the *screw pin*, and seeing that his supply reservoir is properly filled.

d. There is no part of it likely to be deranged; nor is it in the power of thick-headed keepers to put it out of order.

e. The only source of derangement is the clogging the orifice in the *delivery box*, and this is provided against by causing the oil to pass through three strainers from the watch-room tank to this orifice, and, should any dirt reach there, in spite of this precaution, it is only a few seconds' work to take off the top of this box and clean thoroughly this orifice by means of a needle.

f. Experience confirms these statements, as the lamp at Sand Key has now been in daily use for eighteen months* without a murmur from the keeper, or any derangements, except some of the parts which originally were made too slight having to be replaced by those of more strength. These were the connecting pipes, which, being a small gas-pipe, proved not strong enough, and the pump attached to the oil tank, which was not fastened on sufficiently strong for constant service. These defects, arising from want of experience, did not interfere with the use of the lamp, and the changes were made without there actually being absolute necessity for the same.

g. The only formidable objection to the general use of this lamp consists in the probable difficulty of keeping the oil in the *supply reservoir* fluid in northern latitudes.

h. One of the various means for doing this is suggested in the foregoing remarks, viz: to carry the heated air from the chimney of the burner into the reservoir. Ignorance of the practicability of this, or other measures for securing this object, prevents an expression of opinion how far this objection is fatal to the use of the lamp.

i. The accompanying drawings show a second-order watch-room lantern and apparatus, with a hydraulic lamp. It will serve to illustrate the foregoing notes.

REFERENCES TO PLATES, 8vo. SIZE, OF FIRST ORDER, HYDRAULIC LAMP.

NOTE.—The principle of this lamp is the same, with some modifications, as of one constructed under the direction of Captain G. G. Meade, Corps of Topographical Engineers, for Sand Key Light-house.

PLATE I.

DIMENSIONS OF SECOND AND THIRD ORDER LAMPS.

Second Order.

| | |
|----------------------------------|---|
| Diameter of crown of burner..... | 2 $\frac{7}{8}$ inches. |
| Diameter of chimney holder..... | 4 inches. |
| Diameter of glass chimney..... | 3 $\frac{5}{8}$ and 2 $\frac{3}{4}$ inches. |

* At the time this was written.

| | |
|--|--------------------------|
| Diameter of lower reservoir..... | 10 $\frac{7}{8}$ inches. |
| Diameter (exterior) of pump barrel..... | 2 $\frac{1}{8}$ inches. |
| Depth (interior) of lower reservoir..... | 10 $\frac{1}{2}$ inches. |
| Height from M to N..... | 7 inches. |
| Height from M to O..... | 33 $\frac{1}{2}$ inches. |
| Height from P to Q..... | 6 $\frac{5}{8}$ inches. |
| Height from R to S..... | 5 $\frac{1}{2}$ inches. |
| Capacity of lower reservoir..... | 4.22 gallons. |

Third Order.

| | |
|--|---|
| Diameter of crown of burner..... | 1 $\frac{13}{16}$ inches. |
| Diameter of chimney holder..... | 2 $\frac{11}{16}$ inches. |
| Diameter of glass chimney..... | 2 $\frac{3}{8}$ and 1 $\frac{7}{8}$ inches. |
| Diameter of lower reservoir..... | 9 inches. |
| Diameter (exterior) of pump barrel..... | 2 $\frac{1}{8}$ inches. |
| Depth (interior) of lower reservoir..... | 9 $\frac{1}{2}$ inches. |
| Height from M to N..... | 6 inches. |
| Height from M to O..... | 27 $\frac{1}{2}$ inches. |
| Height from P to Q..... | 6 $\frac{1}{4}$ inches. |
| Height from R to S..... | 5 $\frac{3}{8}$ inches. |
| Capacity of lower reservoir..... | 2.55 gallons. |

REFERENCES.

- a a a.* Return pipe from pump.
b b b. Supply pipe from upper reservoir.
c. Glass chimney.
d d. Burner.
e. Chimney holder.
f. Supply pipe and support for burner.
g g. Support for burner.
h h h h. Pinion, to elevate and depress wick.
i i. Rack-sheath.
k k. Ring and clamp-screw.
l. Basin for waste oil.
m. Discharge-pipe for oil.
n n. Regulator valve box.
o. Counterpoise drip-cup.
p. Drip-cup.
q q q. Supports for ring *k*.
r. Throttle-valve of supply pipe *b*.
s. Cock to empty the burner.
t. Handles.
u. Lower reservoir.
w w w. Pump lever.
x. Fulcrum.
y y. Lifting pump.
z z. Supporting rings.
 Capacity of lower reservoir, 7.96 gallons.

PLATE II.

REFERENCES.

Figure 1.

- a a a.* Return pipe from pump.
b b b. Supply pipe.
c. Glass chimney.
d d d. Upper section of sheet-iron chimney.
e e. Lower section of sheet-iron chimney.
f. Damper.
g g. Supporting hooks.
h h. Upper ring of lens frame.
i i i. Adjustable clamping apparatus.
j j. Ventilating space.
k k. Upper reservoir.
l. Strainer.
m. Stop cock.
 Capacity of upper reservoir, 7.78 gallons.

DIMENSIONS OF SECOND AND THIRD ORDER LAMPS.

Second Order.

| | |
|--|---------------|
| Diameter of upper base, upper reservoir..... | 13 inches |
| Diameter of lower base, upper reservoir..... | 10½ inches. |
| Depth of upper reservoir..... | 11¼ inches. |
| Capacity of upper reservoir..... | 4.73 gallons. |

Third Order.

| | |
|--|---------------|
| Diameter of upper base, upper reservoir..... | 10¼ inches. |
| Diameter of lower base, upper reservoir..... | 7¾ inches. |
| Depth of upper reservoir..... | 11½ inches. |
| Capacity of upper reservoir..... | 2.56 gallons. |

PLATES III, IV, V, VI.

REFERENCES.

Figure 1.

- a a a a.* Wicks.
b. Supply pipe and support for burner.
c c c. Channel connecting wicks.
d d d d. Screw for elevating wicks.
e e. Chimney holder.
f f. Supports of burner.
g. Supply pipe from upper reservoir.

Figure 2.

- a a.* Columns.
b b. Supports of burner.
c. Support of burner and supply pipe.

- d.* Strainer.
- e.* Discharge pipe.
- fff.* Ring and clamp screw.
- ggg.* Rack sheath.
- h.* Supply pipe from upper reservoir.

Figure 3.

- a a.* Columns.
- b b.* Deck of lower reservoir.
- c.* Opening in lower reservoir.
- d.* Supply pipe.
- e.* Regulator valve box.
- f.* Discharge pipe.
- g.* Drip cup.
- h.* Counterpoise of drip cup.
- i.* Throttle valve of supply pipe.
- k.* Adjustable stop for drip-cup handle.
- l.* Cock for emptying burner.
- m.* Supply pipe from upper reservoir.
- n.* Return pipe from lower reservoir.
- o o.* Handles.

REFERENCES.

Figure 4.

- a.* Bottom of lower reservoir.
- b.* Strainer.
- c.* Pipe connecting with pump.
- d d.* Cross head of pump rod.
- e.* Return pipe to upper reservoir.

Figure 5.

- a a a.* Columns supporting lower reservoir.
- b.* Pump rod.
- c.* Pump barrel.
- d d.* Pump lever.
- e.* Pipe connecting with pump.
- fff.* Base.
- ggg.* Supporting rings.

g.

PLATE VII.

REFERENCES.

Figure 1.

- a a a.* Upper ring of lens frame.
- b b b.* Clamps.
- c c c.* Ventilating register.

- d. Strainer of supply pipe.
- e. Return pipe.
- f. Chimney.

The large scale drawings of the Light-house Board Portfolio are No. 14, I, No. 14, II, No. 14, III, No. 14, IV, No. 14, V, and No. 16.

PLATE No. 16.

- A. Burner.
- B. Overflow reservoir.
- G. Screw pin for regulating delivery of oil.
- I I I. Oil strainer.
- C. Supply reservoir.
- E. Connecting pipe.
- H H. Stop cocks.
- D. Watch-room oil tank, with force pump and pipe to fill supply reservoir.
- K. Discharge cock for drawing oil out of pipe E.
- L. Pipe carrying heated air of chimney into supply reservoir, with valve shutting off when not required.

FUNCK'S HYDRAULIC FLOAT-LAMP.*

1. All parts of the lamp and burner must be kept perfectly clean, outside and inside.

2. *Summer or warm weather service.*—To fill the reservoir of 1st and 2d order lamps.—Close the stop cock in the supply tube. Put a sufficient quantity of clean oil in the overflow reservoir, and then, with the hand pump, pump it into the supply reservoir.

3. *To light the lamp.*—Having pumped a sufficient quantity of oil into, or filled the supply reservoir, open the stop cock in the supply tube, and after the oil completely saturates and overflows the wicks, light them in the usual way with a lighting lamp.

4. *To extinguish the light.*—Close the stop cock in the supply tube, to arrest the flow of oil from the supply reservoir, and lower the wick until the light is out.

5. *Winter or cold weather service.*—During cold weather, the supply reservoir used during summer or warm weather must be replaced by the reservoir with the smaller tubular aperture or space, and when necessary the spirit lamp must be kept lighted and hung under the float chamber.

6. *To fill the reservoir in cold weather.*—a. The oil must be warmed to a temperature of 90° Fahrenheit before it is put into the overflow reservoir.

b. Open the stop cock, and commence pumping the oil into the supply reservoir.

7. *To light the lamp.*—a. As soon as the supply reservoir is one-fourth filled, and the wicks overflowed by the oil, light the lamp, and light and place the spirit lamp under the float chamber.

b. Having lighted the light, complete the filling of the reservoir.

*Mr. Joseph Funck, the foreman of the Light-house Establishment workshops at the depot on Staten Island, New York, improved the hydraulic lamp of the light-house service by adapting a float to regulate the flow of oil to the burner, as described in the foregoing text, and illustrated by the accompanying plates, 1, 2, 3, 4, which see.

c. To prevent the overflowed oil from congealing in the overflow reservoir, it must be allowed to run off into an oil carrier, which must be kept under the open draw-off cock of the overflow reservoir.

d. After the light is extinguished, in the morning, all the oil remaining in the burner and supply reservoir must be drawn off into an oil carrier, by removing the supply tube.

e. The supply tube must be kept in a warm place until it is required to be used in the evening, and then carefully replaced.

f. The spirit lamp will only be required in extreme cold weather, but it must, nevertheless, be in order, and in readiness for immediate use at all times during frosty weather.

g. In extremely cold weather, it may be necessary to hang the spirit lamp under the supply tube, to keep the oil while passing from the supply reservoir to the burner sufficiently warm.

8. *Damper*.—The damper must be used as with other lamps, for regulating the combustion, the height of the flame, and for retaining the heat from the lamp in the supply reservoir.

9. *Adjusting and replacing the float*.—a. A number of spare floats will be furnished with each lamp.

b. The floats are made of very light material, and must be carefully handled, and kept where they will not be injured by pressure.

c. To replace a float in cases of emergency, unscrew the float chamber from the supply tube and burner.

d. Observe and note the distance of the valve from the float, and in replacing the float by a new one the same distance must be retained.

e. Remove the float from the chamber, and, holding the conical valve with two fingers or a pair of small pincers, unscrew the float from the valve stem.

f. When a new float is placed in the chamber, it must be secured to the burner and supply tube, and the oil allowed to pass through the float chamber to the burner.

g. The overflow of oil, (which, in large burners of all "overflow" lamps must be at least *four times* the quantity burned in the same length of time,) will show whether or not the float is properly adjusted. If the overflow is found to be too great, the distance between the valve and the float must be increased; and if found insufficient, the distance must be diminished.

10. The flow of oil in lamps with only one wick must be so regulated before lighting as to bring the oil to the top of the burner; after lighting, and when the light is at its full height, the overflow of oil during ten hours should be: Fourth order, single wick, one pint; fifth order, single wick, half a pint; sixth order, single wick, half a pint.

DESCRIPTION OF FUNCK'S HYDRAULIC FLOAT-LAMP.

A, supply reservoir; B, supply tubes; C, float chamber; D, float; E, burner; F, overflow reservoir.—(See plates 1, 2, 3, and 4.)

1. The supply reservoir A is made to hold twice the quantity of oil that can be consumed during the longest night, including the waste by overflow.

2. The supply reservoir of a first and second order lamp is filled by means of hand pump, 4, which is placed inside of the overflow reservoir, and the two reservoirs are connected by the pipe 5.

3. The reservoirs of the third, fourth, fifth, and sixth order lamps

are filled from above by means of the oil carrier specially provided for that purpose.

4. The supply tube B* connects the supply reservoir with the chamber C. It is made in two parts, which are united by screw-joint ends, to facilitate the operation of cleaning. It is provided with a stop-cock 8, and has a small aperture at the lower end, through which the oil passes into the float chamber.

5. The float chamber C is connected with the supply tube B and the burner E by screw joint ends. It has a stop-cock 9, by which the aperture 10, leading from the float chamber to the burner, is opened or closed, as may be required. This chamber contains the float D, which regulates the flow of oil to the burner. A small spirit lamp, 11, is placed under the float chamber in very cold weather to prevent the congealing of the oil in the lower part of the float chamber.

6. The float D is made perfectly air-tight, is perforated throughout its entire length by a tubular space 12, and suspended from the valve stem 13 by one cross-bar 14. At its upper end the valve stem terminates in a conical valve 15, which is enclosed in the valve chamber 16. This chamber communicates with the supply tube by the aperture 17, and with the float chamber by the aperture 18. The oil passes from the supply reservoir through the supply tube into the valve chamber; then, owing to the notches in the valve, along the grooves in the valve into the float chamber, without coming in contact with the surface of the float, and, consequently, not impairing its gravity.

7. By hydraulic pressure the oil rises to a level, which, in order to secure an overflow, is a little above the top of the burner, carrying at the same the weight of the float, and raising the valve to a height at which it admits the oil to the burner in sufficient quantity to support good combustion, and a moderate overflow to prevent overheating of the burner and too rapid carbonization of the wicks.

8. The relative distance of the valve from the float is regulated by means of the thread which is cut on the valve stem.

9. The supply of oil to the burner is regulated and the oil supplied automatically by the combined action of the adjustable float and valve.

10. The burner E of this lamp is of the same pattern and description exactly as those of mechanical and other light-house lamps in use for the same orders of lights.

11. Dampers, for regulating the combustion, heights of flames, and the heat to the reservoirs, are fitted, and must be used exactly as required with other lamps.

12. The overflow reservoirs of the first and second orders of lamps are of the same sizes and forms as those of the mechanical lamps of the same orders.

13. The oil is drawn off by a draw-off cock, fitted on a line with the bottom of the reservoirs.

MOUNTING AND SERVICE OF MODERATOR LAMPS ACTING WITH WEIGHTS.

1. *Placing the piston—dismounting the upper part of the lamp.*—To introduce the piston into the reservoir, it is necessary to take off the upper part of the lamp, following the order indicated below:

2. Unscrew the two screws which retain the bent tube to the iron circle.

3. Unscrew also the six screws which fix the iron circle to the brass

* See plates 1, 2, 3, 4.

crown, then lifting up the circle, the whole of the upper part of the lamp comes off with it.

4. *Introduction of the piston.*—As it is very important that the packing of the piston shall not be disturbed at its introduction into the cylinder, it should be protected by means of a tin circle, in which the piston is made to enter until its packing is entirely covered.

5. This circle being placed over the leather packing, lessens its diameter by compressing it, and thus facilitates the introduction of the piston into the lamp. It also has an outer rim, which, stopping it at the crown of the reservoir, allows the piston to descend separately into the lamp.

6. *Mounting of the upper part.*—When the piston has been placed in the reservoir, the upper part of the lamp can be remounted by following the inverse order of that indicated for its dismounting.

7. It must now be ascertained that the joints of the bent tube are packed with leather.

8. *Screwing of the chain upon the filleted arbor.*—To fix the chain on the filleted arbor, a simple inspection of the small piece fixed at its extremity indicates sufficiently the manner of proceeding, so that no error is possible. In this process care must be taken to place the filleted screw at the end of its course when the piston is at the bottom of the cylinder, so that the screw will stop about $\frac{2}{10}$ of an inch from the orifice when the piston is at the top of the cylinder.

9. *Placing in operation with the crank to ascertain that everything works well.*—It is ascertained that everything which precedes has been observed, by raising the piston with the crank, and by shutting and opening alternately the ascension cock.

10. It must be remarked whether the piston feels this operation, and whether the screw carrying the moderating needle has been placed in accordance with what has been stated above.

11. *Placing of the four large cast-iron weights.*—The mounting of all the pieces having thus been carefully made, the four large cast-iron weights are placed in the piston, and afterwards the four small ones above them.

12. Before placing the burners, it is necessary to take out the two small milled-headed screws, and to lower the two lower screws to the lowest point of the tapped rod, in order that the adjustment of the level of the burner may be accurately made.

13. The burner having been placed and leveled sufficiently, the two lower screws are raised until they touch below the feet of the burner.

14. The upper screws are screwed down so as to fix the burner securely. The lamp may then be centered and leveled.

15. *Filling the lamp with oil.*—It must be ascertained that the piston rests on the bottom of the cylinder before the lamp is filled.

16. It is always well to fill the reservoir up to about one inch from the top.

17. *Shutting off the ascension cock before raising the piston.*—To facilitate the passage of the oil below the piston, and at the same time to prevent the introduction of air under it, (which would interfere with the light,) the ascension cock should be slmt whenever the piston is raised with the crank.

18. The piston should be always raised very slowly, without jerks or rough motions.

19. *Opening of the ascension cock.*—The lamp being thus adjusted and ready for operation, the ascension cock should be opened enough to

allow the oil to pass to the burner, and pour a surplus back into the reservoir.

THE MODERATOR LAMP FOR FOURTH, FIFTH, AND SIXTH-ORDER LIGHTS.

1. The moderator lamp is composed of a tin cylinder *A*, in which plays a piston *B*, made of a piece of leather worked to a conical form and attached by tin edgings.

2. Above this piston is a strong spiral spring *C*; one of whose extremities abuts against the lid *D* of the cylinder, and the other upon the piston *B*.

3. In raising the piston, *i. e.*, in making it approach the lid *D*, this spring is compressed, reacts upon the piston, and tends to force it to the lower end of the cylinder.

4. The oil is poured through the funnel *E* into the cylinder *A*, so as to fill the space above the piston *B*, which the spring keeps (as just stated) at the bottom of the cylinder.

5. When the cylinder is thus full of oil, the piston is raised, by turning from left to right the key *F*. On the axis of this key is a little pinion contained in the box *f*, and working the rack *G*, fixed to the piston.

6. As the piston ascends, its leather side yields, and the oil passes between the leather and the sides of the cylinder underneath the piston.

7. When the piston is at its full height, compressing thus the spring as much as it can, it is let go. The spring acting on it from above tends to make it descend, and it would, in fact, descend if the oil which is below it could freely pass again above. But the conical leather jammed against the side of the cylinder forms a nearly hermetic closure, and the oil beneath resists the descent of the piston.

8. The piston is pierced centrally by an aperture, through which passes the tube *H* soldered to it. This tube is open at both ends. Its lower extremity *h* reaches a little below the edge of the piston. Its upper extremity *h'* enters another tube *I*, which is fixed to the burner, and delivers the oil there.

9. The movable tube *H* (that fixed to the piston) works in a leather collar *i i*, fitted in the end of the fixed tube *I*, (the one fixed to the burner.)

10. It can now be understood that the oil, which has passed below the piston as it ascended, and which is now pressed on by the spring, has no other escape than by the tube *H*. From this tube *H* it passes into the tube *I*, and thence to the burner, where it serves to support combustion.

11. The oil unburned flows over the outside of the burner into the funnel reservoir *E*, and thence into the cylinder *A* above the piston.

12. The lengths of the two tubes *H* and *I* are so calculated as that they shall just connect when the piston is at the lowest point of its stroke; and that they shall be completely sheathed (like the tubes of a spy-glass when shut up) only when the piston is at its highest point.

13. It results from this, that during the entire stroke the motion of the piston is free; and that, nevertheless, the communication between it and the burner is uninterrupted.

14. The rapidity with which the oil is supplied to the burner depends upon the pressure of the spring upon the piston, and upon the size of the orifices through which the oil flows.

15. If the tube *I* were entirely open, the oil would pass too easily, and would be furnished to the burner in useless abundance; of course the piston would reach the end of its down stroke in a very short time, and would have to be raised again continually. To avoid this inconvenience, the tube *I* is contracted by means of a small conical iron stem *K*, passing through a leather collar in the upper extremity of the tube *I*, and thus capable of rising or falling in that tube without ceasing to close it, or, to speak more accurately, without leaving any other issue than the burner, to which it conveys the oil.

16. The size of this stem, which is the so-called moderator, is so calculated that the quantity of oil delivered per minute shall be about — drops. But the oil may be thicker or thinner, and thus it may be necessary to diminish or augment the size of the conduit. It is in this view that the stem *K* is made slightly conical.

17. If it is found that the oil is not supplied in sufficient quantity, the stem *K* is to be raised a little, by applying under its head *L*, which is levelled and flattened on purpose, a screw-driver, or any other tool having a chisel edge.

18. The operation of this lamp is now easily comprehensible. Its capacity is such, that when the oil is ascending with a suitable velocity, *i. e.*, from — to — drops per minute, the piston takes from eight to ten hours to come entirely down. At the end of this time it must be lifted again; but it is not necessary with this to put in fresh oil, for the oil consumed is only about one-half of the oil delivered, and all the excess has already replaced itself in the cylinder above the piston.

19. The tin cylinder in which the piston works is itself set in a copper cylinder, which forms the outside case of the lamp. It has at its base a copper ferrule or flange *M*, and is closed by a plate of copper *N*, which flushes against the flange, and is screw-bolted there. The joint is made with a washer of vulcanized caoutchouc.

20. It is not necessary to describe the burner and the wick-holder, which are like those of other lamps.

ACCIDENTAL DEFECTS AND THEIR REMEDIES.

1. If the quantity of oil at the burner ceases to be sufficient, the flame loses brilliancy and becomes red and smoky, the wick carbonizes down to the very edge of the burner, and an excess of oil is no longer seen to run over and distil, drop by drop, into the cistern or funnel *E*.

2. This diminution in the supply of oil may be owing either to obstructions in the supply tubes or to looseness of the piston, which allows a portion of the oil to pass between the leather and the cylinder.

3. The looseness of the piston is known to be the fault whenever, although the supply of oil is insufficient, the piston descends as quick or quicker than when the lamp is working well.

4. For this, the plate *N* must be unscrewed, the oil at the bottom of the cylinder *A* emptied out, and the piston withdrawn, after having first observed if there may not be some dirt between the leather and the cylinder preventing the piston from working well. If this is the case, nothing more need be done than to wipe the cylinder and piston, replace them as before, and screw up.

5. If the piston has worn loose, which will be known by the thinness of the edge of the leather, and by its moving up and down too easily, it is to be replaced by the spare piston accompanying the lamp.

6. If the piston, on the contrary, be in good condition and works well, it will be known by the motion of its down-stroke becoming slower in the same proportion as the ascent of the oil; and then the insufficiency of the supply is caused either by the too great contraction, or by a partial obstruction of the tube *I*. This may be tested by raising the stem *K*, without unscrewing the burner, by the method already spoken of above. If, in spite of this, the supply is still insufficient, the burner, which is fixed to the cistern *E* by three screws, must be taken off, the stem *K* drawn out, and the tubes *I* and *H* cleaned by running through them clear oil, and by scraping their interior with an iron wire, a darning needle, or the stem *K* itself.

7. If the little leather washer *P*, in the lower part of the tube *I*, and through which the tube *H* works, is broken, and allows the oil to pass, it will be necessary to hand the lamp over to a tinner, that he may put in new leathers, and adapt the spare burner to the lamp.

8. The same resort is requisite if any part of the lamp has become unsoldered and leaks.

9. When the burner and the piston have been taken apart, and are to be remounted, great care must be taken in inserting the stem *K* into the tube *H*, and also the tube *H* into the tube *I*. To facilitate this the end of the tube *H* is somewhat levelled off.

10. If the joint at the bottom of the cylinder *A* becomes loose, the screws must be tightened up; if the caoutchouc washer is damaged, it may be taken away altogether, and its place supplied by a little bees-wax.

11. The best means to insure the lamp's working well and not getting out of order, are to put in it only the best oil, perfectly filtered, and to take the greatest care that no scraps of wick or other solid matter fall into it.

12. Even when the supply of oil is sufficient, if the period during which the lamp works without winding up the piston comes to be sensibly diminished, it may be concluded that the piston leaks, and the proper remedy will be what has been described above.

13. The pumps of the lamps and the outside of the burners must be cleaned every eight days with Spanish whiting mixed in a little oil.

14. When the inside of a lamp or of a burner is clogged with oil, it must be cleaned in the manner just stated.

15. Every eight days the exterior of the lamps must be cleaned with rouge mixed with spirits of wine; and the small filter of metallic cloth below the burner must be removed and washed with boiling water.

16. When a lamp is removed from the apparatus to be placed in reserve, the wick must be withdrawn and the oil poured on the filter; the machinery is then slightly wound up, and the lamp reversed over the drain.

17. The outside of the lamp is rubbed with rouge and the burner cleaned.

MECHANICAL MODERATOR LAMPS WITH SPRINGS.

(These lamps are no longer in use in the United States light-houses.)

1. The mechanical lamps formerly in general use, in small lens lights, were *moderator lamps*.

2. The machinery placed in the reservoir of the lamp is formed by a spiral spring, the base of which is attached to a piston.

3. The piston is made of a sheet-iron disk, fitted with a leather washer, and is traversed by the tube which feeds the burner.

4. The foot of the crank, which serves to raise the spring, is fixed upon the piston.

5. The lower part of the burner is supplied with a tube, having a leather box at its base, and an iron stem which passes through the tube traversing the piston.

6. To wind up one of these lamps, turn the key fixed at the top of the button of the rack until it is arrested.

7. It will be necessary to commence winding up at the moment of lighting the lamp, and it will be necessary to renew it afterwards at the end of about six hours' combustion, but it will be advisable to wind up the springs of a moderator lamp at the end of every four hours.

TO FILL THE RESERVOIR OF THE MODERATOR LAMP.

1. To fill the reservoir of the *moderator lamp* with oil, proceed as follows:

2. The movable galary, which holds the glass chimney, and the neck are removed; then pour the oil through the opening of the lamp until it flows to the upper part of the reservoir.

HYDRAULIC OR VALVE LAMPS.

1. In lenses of the 4th order, these lamps with double wicks are sometimes used.

2. The reservoir of the lamp is a hollow cylinder, and is placed above the lens, on the frame-work of which it rests.

3. Through the centre of the reservoir a sheet-iron chimney passes, in the lower part of which is a damper.

4. A register in the upper face of the reservoir surrounds and is concentric with the sheet-iron chimney.

5. When this register is open, the hot air from the flame of the lamp passes up around the chimney, and does not much alter the temperature of the oil.

6. When it is closed, the hot air is obstructed, and heats the oil, so that by this means it is kept fluid in cold weather.

7. From the upper reservoir a brass tube leads to the burner, and is furnished with a stop-cock near the top.

8. The burner generally contains two concentric wicks. It is furnished with a drip cup with a hole in the bottom.

9. The overplus of oil from the burner keeps this cup full, unless there is some obstruction in the flow through the tube leading from the reservoir to the burner.

10. If the flow be obstructed the cup is emptied, and descends, and, by the action of a lever, it opens a valve in the tube, which it keeps partly closed when it is full. The flow of oil will then recommence.

11. In the lower part of the apparatus is a reservoir for the surplus oil, from the lower part of which a pipe, furnished with a stop-cock, leads. By means of this pipe and cock, the lower reservoir can be emptied into a measure or carrier.

OPERATION OF THE LAMP.

1. To place the lamp in operation :
2. The tube, reservoirs, glass chimney, and burner must be perfectly clean.
3. The burner must be supplied with wicks.
4. The upper reservoir must be filled with filtered oil, the stop-cock in the tube being closed.
5. The stop-cock must be opened, and after the oil begins to run freely, and has filled the dripping cup, the wicks must be lighted.
6. As soon as they are lighted, the glass chimney must be placed on the burner, and the damper must be kept nearly closed until the wicks are thoroughly lighted.
7. Then the damper must be gradually opened until it is seen that the flame is white and does not smoke.
8. When the upper reservoir is nearly empty, the oil is drawn from the lower reservoir, and is poured back into the upper.
9. The flow ought to be so regulated by the stop-cock that about four hours will be required to empty the upper reservoir.
10. The greatest cleanliness is required in the manipulation of these lamps, and the greatest care must be taken that all of the oil used has been well filtered.
11. The tin strainers belonging to the various parts of the lamp must be kept thoroughly open and cleaned.
12. If the lamp burns dimly, or cannot be kept from smoking, the rod lamp must be substituted for it; the burner and its tube must be immediately taken off and cleaned, and replaced as soon as possible, or the spare burner should be put on.

Table of principal dimensions of light-house apparatus constructed by Henry Lepaute, Rue de la Fayette, No. 6, Paris, France.

| Designation adopted by Henry Lepaute. | Lanterns. | | | | Lens apparatus. | | | Lamps. | | | | Consumption per burner, per hour, in grammes. | |
|---------------------------------------|---------------------|--------------------|---------------------------------------|--------------------|--|--|------------------|--------------------------------------|-----------|-----------|-----------|---|-------------|
| | Number of uprights. | Interior diameter. | Height of sash incl- sive of bars. | Height of parapet. | Height of focal plane above watch-room floor. | Interior diameter of interior lens. | Number of wicks. | Diameter of wicks in millimeters. | | | | | |
| | | | | | | | | Number 1. | Number 2. | Number 3. | Number 4. | | |
| First order..... | 16 | m. 3.50 | m. 3.32 | m. 2.00 | m. 3.62 | m. 1.840 | 4 | 22 | 43 | 64 | 85 | 85 | grs. 700 |
| Second order..... | 12 | 3.00 | 2.00 | 2.00 | 3.33 | 1.400 | 3 | 24 | 45 | 69 | 85 | 85 | 500 |
| Third order, fixed..... | 10 | 2.50 | 1.90 | 2.00 | 2.85 | 1.000 | 2 | 19 | 39 | 69 | 85 | 85 | 175 |
| Third order, revolving..... | 10 | 2.50 | 2.22* | 2.00 | 3.10 | 1.050 | | | | | | | |
| Third order, special..... | | | | | | | | | | | | | |
| Third order, small model †..... | 8 | 2.00 | 1.40 | 1.00 | 1.72 | 0.700 | 2 | 17 | 35 | 69 | 85 | 85 | 115 |
| Fourth order..... | 8 | 1.80 | 1.12 | 1.00 | 1.47 | 0.500 | 2 | 17 | 35 | 69 | 85 | 85 | 115 |
| Fifth order..... | 8 | 1.60 | 1.12 | 0.90 | 1.47 | 0.375 | 1 | 24 | 35 | 69 | 85 | 85 | 60 |
| Sixth order..... | 8 | 1.40 | 0.90 | 0.65 | 1.39 | 0.300 | 1 | 21 | 35 | 60 | 85 | 85 | 50 |

* 2m. 22 inclusive of small metal base of 0m. 45.
 † 3/4 order, Light-house Board.

LXXXIII.—DIRECTIONS AND INSTRUCTIONS FOR THE USE AND MANAGEMENT OF FOG-SIGNALS.

1. The principal keepers of light-stations, which are provided with fog-signals, will be held to a strict accountability for the proper care, attention to, and management of fog-signals.

STEAM WHISTLES, SYRENS, AND TRUMPETS.

2. The principal keeper of the light-station must satisfy himself, by a thorough, careful, personal examination and inspection of the engine, boiler, and the entire machinery of the fog-signal, before attempting to put it in operation, *that it is in complete and satisfactory working order*, and when it is not in operation all its parts must be dusted daily, and, if necessary, cleaned and wiped off. When the engine is not in operation it must be covered with a tarpaulin or canvas cover, to keep dust out of the journals and off of the friction surfaces.

3. In the event of accident to or derangement of any part of the machinery, it must be reported immediately, unless the injury be of such a kind that the keeper is able to make the necessary repairs himself, otherwise the facts are to be reported immediately to the Light-house Engineer or Inspector of the district easiest reached, accompanied by such detailed report as will enable the officer to whom the report is made to provide the necessary assistance and materials for putting the fog-signal in efficient working order in the shortest time. Hand force-pumps with pipe connection cocks, &c., should be provided for every steam fog-signal boiler.

4. The engine-room must be kept clean; the unpainted parts of the machinery kept free from dust, dirt, and rust, and the painted parts wiped dry at all times and well oiled.

5. No dirty waste, cotton, or woollen rags, or cloths saturated with oil, are to be left in boxes, corners of the room, or elsewhere, where they might become ignited from spontaneous combustion, but when the wiping off of the engine and machinery has been finished, these articles are to be thrown into water in buckets for washing, or, if unfit for further use, to be thrown into the furnace of the boiler to be burned.

6. Should the steam boiler have a heater attached to it for keeping the water in it warm preparatory to raising steam, firing under it should be commenced at the moment of the earliest indication of there being probable necessity for using the fog-signal soon, which must be continued, with the draught so regulated as to raise the temperature of the water in the boiler from 190° to 210° Fahrenheit as speedily as possible.

7. Having the water in the boiler at the temperature of 190° to 210° Fahrenheit from the heater, as soon as it is seen that the fog-signal will be required, commence firing judiciously in the furnace, and when there is sufficient steam for operating the fog-signal effectively and continuously, according to its distinguishing character, put it in motion, noting the time, state of the weather, &c.

Whenever the fire is allowed to go out, or is drawn from the boiler, the furnace and ash pit should be thoroughly cleaned, kindling wood

placed in the furnace, *and everything made ready for lighting* when it shall be again needed.

In starting the "getting up steam" in the boiler, the fire should be controlled to burn moderately, and the safety-valve kept open until the steam escapes freely, when the valve may be closed and the fire permitted to burn to full activity.

8. In cold weather, with indications of fog or snow, the water in the boiler should be kept at 190° to 210° Fahrenheit by the heater; but great care must be taken, in firing, not to force the heater so much as to run the risk of so rapidly evaporating the water in it as to burn the heater.

After the heater is in full action, there will be nothing to fear in "forcing" the heater, if the connecting pipes are of proper size and clear; these pipes should be occasionally examined to see that they are unobstructed.

If in any case the attendant finds the temperature increasing in the heater, so that steam is making, and there is no increase of temperature of the water in the boiler, there will be reason to apprehend that there is some obstruction in the circulation between the heater and the boiler, and the fire should be hauled or allowed to die out in the heater, the fire having at the same time been started in the boiler.

As soon as the use of the boiler ceases for the occasion an examination should be made, to ascertain if any, and what, obstruction there was to the circulation.

9. While the keeper is getting up steam, he must be careful to oil all the working parts of the machinery, and by close inspection see that all the oil holes are clear, and that they take the oil freely. As often as once a month (as there may be opportunity) the several wearing parts must be taken apart and carefully cleaned and oiled.

10. At all times, while the engine is in operation, see that there is, as near as may be, *two cocks of water in the boiler*. Should the water in the boiler foam, prime, and rise at any time while in operation or raising steam, shut off for a few moments for the foaming to subside, then ascertain the quantity of water left in the boiler, when open again and increase the quantity of feed water to supply deficiency.

The aim should be never to have less than two cocks of water.

If the boiler shows a disposition to foam or prime, the valves should not be opened suddenly, but gradually, or if necessary to open suddenly for short blasts, it should be closed quickly, before the foam can rise to obstruct the flow of steam. (In the whistle machines the opening of the whistle-valve is always sudden, and cannot be closed except suddenly, and after the full duration of the blast, without changing the characteristics of the signal.)

11. *Boilers that foam must be pumped up or fed with great care*, yet observing the safer course of pumping enough, and never allowing the water to get out of sight. If it should occur that, from any cause, the water should fall below the gauge-cocks and glass, *do not haul fires, and do not put on the feed, or change any valve, nor open the safety-valve*, but charge the furnace full of the finest coal at hand, so as to completely deaden the fire, leave the fire door open and close the damper partially. Keep everything in this condition till the boiler cools off, *occasionally sprinkling water on the fire, if necessary*, to keep it deadened. After the boiler has cooled down, refill the water to the proper height, examine to ascertain if the pump is out of order, or from what cause the water

has fallen too low in the boiler, clear out the furnace, recharge with kindling, and prepare everything for again lighting fires.

12. The *gauge-cocks* must be kept in good order at all times, and while the machine is in operation, or steam raising for work, they must be frequently tried. They must be kept open, and answer properly whenever tried. The glass gauge must not be wholly depended upon.

The *glass gauge* must be frequently "*blown out*," to see that all the passages and valves are clear.

13. The safety-valve must be kept in good working order at all times, and be frequently examined while the machine is in operation.

The safety-valve must be taken apart *once a month*, to see that it is in good order and clean, and that it works freely.

14. Regular and continuous pumping is essential to the economical consumption of fuel, which can be easily done by giving a little attention, and by partially closing the cock in the pipe which supplies the pump, *but no pipe between the pump and the boiler should be closed at all*. A few trials will enable the keeper to determine the proper point at which the supply-cock should be closed, which point, when satisfactorily ascertained, *must be marked*, to serve as a guide afterwards.

The keeper must not rely upon the *fact that the valve is open* which supplies the water to the pump, but must frequently examine the glass gauge and try the gauge-cocks, as, although the supply-valve to the pump is open, the pump may cease working, and the fact not be discovered till the water is too low in the boiler.

15. The furnace door should be kept closed as much as possible, governing the fire mainly by the damper in the chimney.

16. While firing, and during work, keep the ash-pit door open, but close it when work ceases.

17. The furnace doors of tubular boilers must not be opened wide for "*cooling down*." The sudden admission of cold air will contract the tubes too suddenly, and fracture them, causing leaks; but they may be partially opened to aid in cooling down the boiler.

18. The space below the grate bars in the ash pit must be kept free from ashes and cinders; should they be allowed to come in contact with the grate bars, they would soon melt. When the engine is at work, the ash pit must be cleaned out at least as often as once a day.

19. The boiler and flues should be brushed clean daily if possible, and although no positive rule can be laid down for periodical cleaning, it must not be forgotten that they are never to be foul. After 30 or 36 hours' firing (and oftener if the draught is found to be sluggish) the necessity for brushing out the flues, to remove ashes and soot, will be apparent.

20. When the engine is stopped, clean the boiler and flues, and put everything in order at once for starting the signal again.

21. In case there should be at any time a difference in the indications of the steam-pressure gauge and the safety-valve, lose no time in ascertaining the cause, and apply the proper remedy to the defective instrument at once.

22. As the water used in the boilers may be of a different quality at different stations, special attention should be given to it. When the water used holds *salts in solution, or mud, or sediment in suspension*, more frequent blowing off will be necessary than if the water is pure and entirely free from those impurities. Care and good judgment are required in the management of boilers under these circumstances; but,

above all, it is necessary to be very careful to prevent the deposit of mud, lime, salt, or other solid matter in the bottom of the boiler, inasmuch as such deposits endanger both life and property. Deposits of mud will be readily seen by its accumulation about the gauge-cocks, and by the "*spatter*" from the cocks being foul.

The "water blow" should be opened once in twelve hours, if but for a moment, simply to start the sediment, and longer if the water "blows foul," taking care, however, to shut the valve or cock before the water is too low in the boiler.

Do not leave the blow-cock for an instant, *while open*, but be sure to shut before leaving it.

23. In case sea water is necessarily used continuously, frequent, but light blowing off, should be resorted to, in preference to occasional exhaustive blowing off, as the latter course necessarily prevents uniformity of work by the engine.

If sea water is used, blow off, for a short time, every two hours, and as often as the boiler is cooled down and opportunity offers. Open the boiler and examine the tubes to see if there has been any scale or deposit made upon them; if so, the amount of water blown off has not been sufficient and must be increased.

"STEAM-BOILER INCRUSTATION.

"Water is rendered hard by the presence of earthy salts, such as carbonate of lime and magnesia, and these are kept in solution by the aid of the free carbonic-acid gas which the water contains. By boiling, the gas is expelled and the salts precipitated, when they appear as a crust on the bottom and sides of the vessel, as may be seen in any old teakettle where hard water has been habitually used. Dr. J. G. Rogers, in an important paper read at the recent meeting of the American Association for the Advancement of Science, after enumerating the various substances which in boiler waters contribute toward the formation of this crust, gives us some valuable practical information concerning the effect of the crusts upon the boilers, and how their formation may be prevented. Both dissolved and suspended matters are thrown down by boiling and evaporation, and slowly accumulate as a whitish, tough, porcelain-like layer, which may attain an unlimited thickness. The evil effects of this formation are due to the fact that it is a poor conductor of heat. Its conducting power, compared to that of iron, is as one to thirty-seven and a half. This known, it is readily appreciated that more fuel is required to heat water through scale and iron than through iron alone. It has been demonstrated that a scale one-sixteenth of an inch thick requires the extra expenditure of fifteen per cent. more fuel. As the scale thickens the ratio increases; thus, when it is one-fourth inch thick sixty per cent. more fuel is required; at one-half inch, one hundred and fifty per cent., and so on. To raise steam to a working pressure of ninety pounds, the water must be heated to 320 degrees Fahrenheit. This may be done through a one-fourth-inch iron shell by heating the external surface to about 325 degrees Fahrenheit.

"If a one-half-inch scale intervenes, the boiler must be heated to 700 degrees Fahrenheit, almost a low red heat. The higher the temperature at which iron is kept the more rapidly it oxidizes; and at any temperature above 600 degrees it soon becomes granular and brittle from carbonization or conversion into the state of cast iron. Weakness of boiler

thus produced predisposes to sudden explosions, and makes expensive repairs necessary. To prevent the formation of scale, the author recommends the use of tannate of soda. This is put into the boiler at regular intervals in amounts proportioned to the hardness of the water. It quickly dissolves, and, without foaming or injury to the boiler, effectively accomplishes the desired result. In the reaction which takes place the tannic acid leaves the soda and combines with the lime of the carbonates to form tannate of lime. This is precipitated as a light flocculent, amorphous substance, which does not subside, but eventually finds its way to the mud receiver, in the comparatively still water of which it is deposited as a mushy sediment that may be readily blown off as often as required. The sulphate of lime is decomposed by the carbonate of soda of the first reaction, soluble sulphate of soda and carbonate of lime being formed. The latter is converted into tannate of lime by fresh portions of the tannate of soda. The presence of the alkali prevents all action of the acid on the iron. Extensive practical trial of this method has demonstrated its utility in all kinds of boilers, and its perfect efficacy, safety, economy, ease of application, and general adaptability will commend it for general use."

FIRING.

24. In firing with *anthracite coal*, the bed of fuel should be as thin as can be carried, so that there are no holes for cold air to pass through the fuel; as a rule, the smaller the coal, the thinner the fire. With bituminous coal, the fire *must be thicker*, to avoid air holes through it; also, if the bituminous coal is "binding" coal, that is, runs or binds together, it must be occasionally broken or lightened up, with the "slice bar," to keep the fire open. A well-constructed steam-boiler is fitted to do its work best *when consuming a certain fixed quantity of fuel*, (coal or wood.) Above or below this point there must be more or less waste, and there is as much above it as below it.

HAULING FIRES.

25. *Haul all fire always before blowing down*, and be careful to see that no fire is left under the boiler when blowing down is commenced. Keep the furnace and ash-pit doors closed, to prevent too sudden cooling of the boiler and the consequent fracture by too sudden contraction of the tubes.

TO START THE ENGINE.

26. *See that the cylinder waste-cock is open*, and all the water in the cylinder from condensed steam is removed before starting the engine. As soon as the engine becomes warm, attend to the pump and see that it works well, to prevent any detention on account of a want of a proper quantity of feed water.

TO STOP THE ENGINE.

27. When there is no longer necessity for working the engine, open the drip-cock of the steam-cylinder (and in cold weather open also the cocks

in the pipes) to allow all the water to run out of them, to prevent damage by freezing.

THE SYREN STEAM FOG-SIGNAL.—(SEE DRAWINGS.)

Description of the apparatus.

Figure 1 is a top view.

Figure 2 is a front view.

STEAM BOILER, FIGS. 1 AND 2.

- 1, Gauge-cocks.
- 2, Water-gauge.
- 3, Safety-valve.
- 4, Man-hole.
- 5, Heater.
- 6, Feed and connection pipes between the heater and the boiler.

THE SYREN.

- 7, Cylindrical chamber, provided with steam ports (8) and passages (9.)

This chamber is held in its seat by the flange (10,) and is provided with a sleeve which has a screw thread at its ends, and is packed by means of a nut (12) and a stuffing box (13.)

Through chamber (7) passes the shaft (14,) upon one end of which the syren (15) is screwed and held in place by a lock nut.

On the other end of the shaft is placed a pulley, (16,) which is rigid, and motion is imparted to it by the fly-wheel of the engine. The collars (17) keep the shaft in position. After loosing the collars (17) the syren is regulated (that is to say, the same is brought as near as possible to the surface of the chamber, but not so near as to impede the movement of the syren) by means of the set screw of collar (18,) which is rigidly secured to the shaft. The syren shaft runs through both bearings (19,) and through chamber (7,) as above described.

The bearings (19) are provided with lubricators filled partially with cotton, which, after being pressed tightly against the shaft, are saturated with oil. Two additional oil cups are provided for the shaft on the casing of the syren. The person in attendance upon the syren must take special care to see that the shaft is always well supplied with oil.

In the shell of chamber (7) is a valve which opens and closes the steam ports (8.) That valve is provided at its lower end with teeth which come into gear with the wheel (21.) This wheel is on shaft (22,) and motion is imparted to it by the lever (23) and the pitman rod (24,) which extends to the engine. Lever (25) is raised by means of a weight, and thereby the valve is closed. A flange is provided (10) with a ball-shaped collar, which permits the downward movement of the trumpet (27,) and furnishes a steam-tight connection with it.

THE ENGINE.

A pulley (28) is on the fly-wheel shaft. The motion is transmitted from this pulley, (29,) which is placed on the same shaft with a worm, (30.) This worm imparts motion to the worm-wheel (31) to which is secured

a carrier, (32.) This carrier (32) pulls the pitman rod (24) downwards, and causes the opening of the valve (20) whenever it comes in contact with a roller (33) placed at the lower end of the pitman rod (24,) steam-valve (34,) governor (35,) pet-cock (36.) The pet-cock must be opened on starting the engine, and must remain open until there is no water in the cylinder. It must also be opened when the engine is stopped.

Feed-pump, (37.)

Air-cock, (38.)

The air-cock must be opened whenever the pump is not required to feed. For the purpose of accelerating the suction of the pump, after it has been idle for sometime, the air-cock (38) and the water-cock (39) are to be opened and water introduced into the pump through the latter until it reaches the air-cock (38.) Then both cocks must be closed instantaneously.

A section valve, (40.)

Discharge valve, (41.)

Air-vessel, (42.)

Safety-valve, (43,) by which the bursting of the feed-pipe is prevented, in case the stop-cock (44) should be closed. The stop-cock (44) should always be open, and may only be closed in case it should become necessary to inspect the pump-valve while the pump is in operation, or the boiler water is blown off. The blow-off cock (46) is always closed except when it is necessary to blow off. The cock (67) stops the feed-pipe from the hand-pumps, and is opened when the boiler is to be fed by the latter.

Different parts of the apparatus are marked with numbers, on the drawing, of which no mention has been made in this description. They are merely numbered to prevent mistakes in case new ones should be required to replace old ones.

28. The pressure of steam having reached twenty pounds, the engine and syren may be put into operation and continued.

The steam pressure should be maintained uniformly as nearly as possible at seventy pounds, and never, if it can be avoided, to exceed eighty pounds.

In case of disarrangement of the valve-gear inside of the stand-pipe of the syren, take off the hand-hole plates, and see that the defects are remedied; that everything is secure inside, and that the keys and pins are in place.

DIRECTIONS FOR OPERATING THE ERICSON CALORIC ENGINE AND DABOLL'S FOG-TRUMPET.

29. The engine and engine-room must be kept clean and free from dirt in all its parts, and the engine in condition to have the fire lighted at a moment's notice. To do this the furnace must have been cleaned after last using, and fresh kindling placed upon the grate, ready to be lighted when needed.

30. During the time of firing up, let the crank of the engine point towards the furnace door.

31. Keep the fuel upon the grate at a uniform height, and never allow it to touch above the linings.

32. The ash-pit, under the grate, must be kept free from ashes and other dirt.

33. Ashes and dirt collected in the jacket around the cylinder should

be cleaned out once each week; this can be done through the narrow door or loose plate under the ash-pit.

34. The starting is effected by working the fly-wheel about half round by the starting bar. Watch closely after lighting the fire, and start as soon as the engine will work. The time when it will work can be determined only by attempts to start it. If not started at the proper time, and too much delay takes place, the heater will be destroyed.

35. The engine is stopped by opening the exhaust valve on the top of the cylinder; keep this valve open until the engine is at rest, and open the furnace door before stopping.

36. While at rest, the furnace door must be kept open, and the wheel turned *so as to bring the piston full out*; if this is not done, as directed, the heater will be destroyed.

37. The cylinder is best greased *with a swab dipped in melted tallow*.

38. The *journals, and all joints and bearings*, must be oiled with good clean oil.

39. Never put oil upon the stem of the exhaust valve.

40. By the damper, combustion may be checked or increased, and the power of the engine governed thereby.

41. A thorough examination, *both internal and external*, must be made at intervals of two months, so that a correct knowledge of the condition of the motor may be had.

42. When new leather packing is needed for the piston, cut a ring of good stout calfskin, one-half inch larger in diameter than the bore of the cylinder; this must be attached to the piston in the same manner as the old one was, with the flesh side of the leather turned outward, towards the cylinder. In case the piston is too large, when the packing is new, and cannot readily be put in the cylinder, *make a very light fire in the cylinder*, so that it may be expanded; *but use great care*, and do not get it so hot as to burn the leather.

43. The stuffing-box through which the piston-rod works, *should be screwed moderately tight only*. Lamp wick, or any other elastic material, will answer for packing.

DABOLL'S TRUMPET.

44. The *reed or tongue* is the most delicate part of the trumpet. The *trumpet* needs only to be kept clean and free; any fracture which may occur from excessive vibration may be repaired with hard solder by the visiting mechanic.

The *tongue or reed* should be fitted so as to get a satisfactory tone—if too flat, make the point thinner; if too sharp, make the back end thinner. By trial, the best results can be soon obtained. Also, *try different reeds at different pressures*; and use that pressure which gives the best tone with each particular reed.

45. Duplicate reeds will be furnished at all times when needed by application to the proper authorities, and the station should never be without two or more in store.

SUPPLEMENTAL.

DIRECTIONS FOR MANAGING STEAM FOG-SIGNALS IN THE ELEVENTH LIGHT-HOUSE DISTRICT.

First. The signal being for the first time ready for use, fill the tank by hand, and prepare the fires in the furnace for starting.

Second. See that the "blow-off cock" is shut, and then upon the first indication of thick weather open all the cocks in the pipes leading from the tank to the boiler, and when the level of the water in the boiler reaches the lower cock, and not until then, close these cocks, start the fire and get up steam as rapidly as possible, using the steam jet whenever necessary to force the draft.

Third. When the pressure reaches sixty (60) pounds, start the engine; pump the tank full; run the pressure up to ninety (90) pounds as quickly as it can be done.

Fourth. While the thick weather lasts keep the steam pressure uniformly between eighty (80) and one hundred (100) pounds, preferably about ninety (90) pounds; the water in the boiler between the lower cock and the one next above; pumping the water supply from the well whenever possible, and only pumping from the reserve supply in the tank when absolutely necessary.

Fifth. When the weather clears up, see that the tank is full, then draw the fire; let the engine run until the pressure in the boiler is reduced to between fifteen (15) and twenty (20) pounds; then open the blow-off cock and empty the boiler, and when this is accomplished close the blow-off cock.

Sixth. Thoroughly clean the furnace; prepare a new fire for lighting; start a fire in the heater, and keep the water in the tank warm and ready for use in filling the boiler when it is desired to again start the signal.

The operation of the heater will, by evaporation, cause some loss of water from the tank. This loss must be supplied by hand, and the tank kept full.

Seventh. When it is desired to again start the signal, fill the boiler as before, from the tank, then start the fire in the furnace and proceed as already prescribed.

Eighth. Always keep the bright parts of the engine and apparatus clean and the whole machine in perfect order. Immediately report to the Engineer or Inspector of the district any defects, in order that they may be promptly remedied.

Ninth. Great care must be exercised to avoid the effect of freezing weather. Fire must be constantly kept in the heater; all the pump "pet-cocks" must be kept open. If the weather is very severe it will be well to keep low steam (say five to ten pounds) on the main boiler, keeping the temperature in the engine-house, if possible, sufficiently high that a thermometer at the floor will not fall to the freezing point.

Tenth. When the apparatus is to be laid up for the winter, be sure that the water is all out of the pipes; leave all cocks open; take off the pump-doors and the check-valve cap; empty the tank.

Precautions which must be observed.

The cocks between the boiler and tank *must* be closed before the fire is started.

Water *must* be kept in sight at the lower gauge-cock during all the time steam is on the boiler, and it ought not to appear at the next cock above.

Whenever the apparatus is in operation a keeper *must* be in the engine-house, in charge, and *awake*. It will not answer to leave the machinery alone for a single moment. If it should be necessary for the keeper immediately in charge to quit the engine-house, some competent person must temporarily relieve him.

DIRECTIONS FOR OPERATING AND KEEPING IN ORDER STEVENS'S FOG-BELL STRIKING APPARATUS.

1. Keep the machine clean and free from dirt and rust in all its parts. This can only be done by constant care and attention, in wiping with waste or cloths which are slightly saturated with oil; care must be taken not to use so much oil that passing particles of dirt will adhere to the surface.

2. Care must always be taken to keep the machine as dry as possible, by stopping closely the opening in the side of the room or ceiling through which the connection between the hammer and the machine passes, so as to prevent rain or spray from passing in and wetting the machinery.

3. Before starting the engine *be sure that the machinery and the hammer are well oiled in all bearings and points of contact where friction exists by one surface moving upon another*, with some pure lubricating oil.

Upon the clock-work, which regulates the intervals between strokes, a *fine oil*, such as is used upon clocks, would be preferable. Avoid putting on too much oil, for by that means the machinery and surroundings will become filthy, and catch and retain all flying particles which come in contact with it; yet be sure that enough oil is always on, so that the parts may not run dry and cut. *Never leave this machine alone while running*. Some competent person must be in constant attendance upon it, to rectify any irregularity and prevent accidents which might occur.

4. *Always remove the winding crank as soon as the machine is wound up*, and see that no obstruction is in the way of the weight, whereby it might be prevented from acting equally at all times upon the machine.

5. Be sure that the hammer, and the rod connecting it with the machine, does not come in contact with any of its surroundings during the operation of striking.

6. If any part or parts of the machine are to be removed for cleaning or repairs, *be sure always to run down or support the driving weight of the machine*. Never disconnect any part of the machine until this weight is secured, so that it will not operate it.

7. Never let the wire rope which supports the weight which actuates the machine rub or chafe against any surrounding parts.

8. In case the clock-work has not enough power to throw off the falling lever or cam which liberates the striking weight, move the brass weight which actuates the clock-work further from the centre, and *towards the end of the lever*. This will *increase the power*, and, *moving the weight toward the centre will diminish the power*.

9. If the falling lever operated by the pins *falls*, but does not have

the power to liberate the striking levers, the power may be increased by moving the brass weight toward the *outer end of the lever*, and if the weight is too great move the weight toward the centre or fulcrum of the lever.

10. Before making any alterations in the machine, it would be well to examine it thoroughly and see if the difficulty does not arise from some cause independent of the machinery.

11. Do not use any more weight to drive the machine than will give a good sharp blow, or give the best result in tone and loudest sound from the bell struck.

The sections of the weight furnished weigh one hundred pounds each, except the section which has the hook attached, which is heavier. Three hundred pounds will strike a sharp blow, and four hundred pounds a very hard blow; proportion the weight and blow to the bell struck.

DIRECTIONS FOR THE MANAGEMENT OF "ANDERSON'S" HAND FOG-SIGNAL.

1. This instrument should be kept clean in all its parts.
2. Avoid bruising or indenting the cylinders.

Should such accident occur, introduce a round piece of smooth wood, as large in diameter as the cylinder will admit, and with a small, round, hard stick rub and press the indented part until restored to its original form as near as possible. Avoid drawing the metal, which would permanently injure the instrument.

3. As long as the instrument gives good tone, do not meddle with the tongue or reed in any other way than to wipe and keep it clean. Observe when the instrument is in good order the position of the reed relative to the reed-seat, then, should accident occur to the reed, put it in the same relative position as it was originally, and try the tone of the instrument. This need only be done when no duplicate reeds are in store. When duplicates are at hand, replace the injured one with a new one, and preserve the injured one that it may be repaired.

3. The packing upon the lower end of the piston cylinder can be renewed when worn with lamp wick or other similar material, which material should be filled with clean tallow when applied to the piston.

4. Use great care to keep sand and all similar substances out of the instrument.

DESCRIPTION OF CUSTER'S FOG-BELL STRIKING MACHINE, WITH PAUSE.

Designed to strike a bell of 380 pounds weight, a blow of the hammer at intervals of ten seconds (10") for four successive blows, and then pause for thirty seconds, (30") then four blows again, and so on—a hammer of 20 pounds weight. The hammer arm is 20 inches in length, and raises the hammer 6 inches at each blow. It has a retaining power, and is wound up by half a man's strength, applied to an ordinary crank key. The motive weight is hung directly on the winding cylinder, and is composed of 18 cast-iron disks, each one 16 inches in diameter and 2½ inches thick, weighing about 120 pounds—2,160 pounds for all of them. If the weight is found to be too heavy, one or more of the disks can very readily be taken off.

The length of the fall for the motive weight must be regulated according to circumstances. 25 feet of chain is furnished with each machine. The weight will fall about 40 inches per hour while the machinery is in full operation.

Description of and directions for setting up and running Custer's Fog-bell Striking Machine, with a Pause.

The floor upon which the machine is to stand should be firm, so as not to spring when the motive weight is attached.

There must be room around the machine to allow ample space for cleaning and oiling it.

The works must be clean when they are set up.

The plate with the figures stamped on the boxes must be set up on the floor, and the pillars put in on the side on which the centre punch-marks are, at the top of the corner holes, so that the centre punch-marks on the pillars will agree with the same marks on the plates. Put in the back keys loosely, and brace the plate plumb at the top. Put in the second wheel, (Figure 2 to 2,) then put in the first wheel, (Figure 1 to 1,) and put a block under the wheel (in front) to keep the weight off of the back journal.

Then put in the third, fourth, and fifth wheels, fan and hammer-drop (7,) as marked, and let them hang on their journals.

Then put on the front plate. Be careful to enter the pillars and journals so as not to bend them. Put in all the keys, and key all up tight. Place the machine on the floor so that the chain will have room to move over and fill the cylinder as it is wound up.

Then put on shaft (4) the pause pinion; put on the pause wheel and screw its pin up firmly. Put in the pause shaft from the back, so that the brass wheel and washer will come outside of the front plate, and pin it up tightly. Then put up the hammer so that the ball will be held $1\frac{1}{4}$ inch above the sounding ring of the bell, and spring and strike the bell when the hammer falls.

The two angle-irons furnished are not to be used unless it cannot be avoided.

Put on the motive weights and wind up the machine; unpin the pause wheel and set it so that the pause segment will begin to move to the pause pinion just after the fall of the hammer, and so that it will pass the pause pinion before the next fall of the hammer.

The pendulum can be regulated by moving the ball up or down on the rod. The pin on which the pendulum works must be screwed fast to the plate to prevent its jarring loose.

The fan can be taken out and cleaned and oiled at any time when the weight is down, *but it must not be taken out when the machine is wound up.* The pause shaft can be taken out and cleaned by taking off the brass wheel.

All the journals and teeth of the wheels must be kept clean and well oiled.

The best quality sperm oil should be used for lubricating in warm weather, and clock oil in cold weather. *The clock oil should only be used on the fan and fifth wheel.*

DESCRIPTION OF CUSTER'S FOG-BELL STRIKING MACHINE, WITHOUT PAUSE.

Designed to strike a bell of 500 pounds weight, a blow of the hammer

every ten seconds (10") continuously—a hammer of about 25 pounds weight.

The hammer arm is 20 inches in length, and raises the hammer about 7 inches each blow. It has a retaining power, and is raised up by one-half a man's power, applied to an ordinary crank-key. The motive weight is hung directly on the winding cylinder, and is composed of 20 cast-iron disks, 16 inches in diameter and $2\frac{1}{2}$ inches thick, weighing about 120 pounds each, 2,400 pounds. If the weight is found to be too heavy, one or more of the disks can readily be taken off.

The length of fall for the motive weight must be regulated according to circumstances.

The weight will fall about 4 feet per hour while the machine is in full operation.

25 feet of chain is furnished with the machine.

Description and directions for setting up and running Fog-bell Striking Machine, without a Pause, by J. D. Custer, maker.

The works must be cleaned off before setting up.

The large wheel must be bolted on the cylinder as the centre punch indicates.

Put up the plate which has the figure marks on the bosses near the holes, and put in the four pillars as they are marked by centre-punch marks near the tops of the corner holes, so that the marks on the pillars correspond with the marks on the plates, and put in the keys loosely.

Brace up the top of the plate to keep it plumb.

Put in the second wheel, Figure 2 to 2. Then put in the first wheel, 1 to 1, place a block under the wheel in front to keep it level.

Then put in the third, fourth, and fifth wheels and fan, and hammer shaft No. 7.

Then put on the front plate. Be careful to enter the pillars and journals so as not to strain or bend the back journals, and then key all up tightly.

Place the machine in position, so that the chain will wind up and fill the cylinder one thickness, (about 12 rounds,) and give room for the weight to descend without rubbing.

Place the hammer seat in position, and bolt it fast, so that the ball of the hammer will strike the sounding ring of the bell; the spring of the hammer arm will keep the hammer about a $\frac{1}{4}$ inch off the bell.

The two angle-irons are to be used only when it cannot be avoided. The connecting wire from the clevis on the hammer-drop No. 7 to the clevis on the hammer-arm must be put on so as to allow the hammer to strike the bell freely; if the wire is too slack it will not raise the hammer high enough, and some of the power will be lost.

The fan No. 6 can be set in to make the machine run faster, and out to make it run slower.

Placing the connecting wire to make it lift the hammer higher will make the machine strike slower.

If the wire is set to lift the hammer too high the machine will stop.

Best quality sperm oil should be used for lubricating the works in warm weather, but in cold weather clock oil should be used, as it does not gum or chill. The clock oil should not be used in warm weather, as it dries and forms a red rust or powder, and injures the journals. It should only be used on the fan and fifth wheel.

PAINTING IN THE LIGHT-HOUSE ESTABLISHMENT.

INSTRUCTIONS, &c.

LXXXIV.—INTERIOR OF LIGHT-HOUSE LANTERNS.

1. The whole interior of light-house lanterns (dome, astragals, ventilators, smoke conductor, &c.,) is to be painted WHITE, and must be kept clean, free from soot and grease, and the white paint renewed as often as necessary.

2. The paint may be kept clean and free from soot and grease by occasional scrubbing and washing with clear, soft hot water and soap, followed by clean water. If from bad ventilation, neglect, or from any other cause, the interior of the dome, the astragals, &c., have become very dirty, and the soot and grease cannot be removed by scrubbing with hot water and soap, then the lye of wood ashes (oak or hickory) will remove it. In case lye cannot be had, then it may be washed with strong lime water, which will answer nearly as well as strong lye. Lye is not, however, to be used in cleaning wood work for painting or re-painting.

a.—EXTERIOR OF LIGHT-HOUSE LANTERNS, ETC.

1. The exterior of light-house lanterns, balustrades, railings, ventilators, cowl, &c., are (except in special cases) to be either BLACK or RED. The whole of the exterior of the lantern is to be kept the color fixed for the dome, cowl, &c. Refined coal tar will be used for all iron work, except that painted white or red.

b.—TO PREPARE FOR PAINTING.

1. Paint will not adhere to and dry upon wood or metal which is not perfectly clean and entirely free from soot and grease.

2. Soot must be removed by brushes and cloths or towels, and by washing with hot soft water and soap.

3. Oil and other grease on wood work must be removed by the use of spirits of turpentine and a worn or other stiff brush, rubbing the part vigorously until the stains are removed. When the above means have been resorted to without entire success, mix a thin whitewash; strain it, and give the parts to be painted a coat of it with a paint brush. When this whitewash becomes thoroughly dry, take a clean brush and with it remove all the whitewash, and the parts thus treated will be in proper condition for receiving the paint.

4. Iron, brass, copper, &c., must be cleaned so as to present a smooth surface. All blistered and cracked paint, and all rust on iron, must be carefully removed and the parts smoothed before putting on the paint. (See receipt for preparing caustic potash lye.)

c.—TO PREPARE PAINT FOR INSIDE WORK.

1. Take the necessary quantity of paint from the keg and mix spirits of turpentine with it until it is of the consistency of CREAM; then put in patent drying or Japan varnish, in the proportion of one gill for each gallon of paint, and mix the paint, turpentine, and drying well together; the paint will then be ready for immediate use. When the paint in the paint bucket becomes thicker than cream, it must be thinned by adding small quantities of spirits of turpentine, and it may be necessary to add also a very small quantity of boiled linseed oil at the same time, to increase its drying qualities.

2. Black paint for inside work will be greatly improved by mixing it with spirits of turpentine and copal or coachmaker's varnish. The varnish will give the paint, when dry, a gloss.

3. Black paint for inside work may be prepared with *dry lampblack*, mixed with copal or coachmaker's varnish, and then thinned to the consistency of cream with spirits of turpentine. One pound of fine lampblack will require about half a gallon of varnish to prepare it to receive the spirits of turpentine.

4. No oil is to be mixed with paint which has been ground in oil in preparing paint for inside work.

5. RED LEAD is put up dry. Quantities required for immediate use only are to be mixed. If not used immediately after being mixed, it becomes hard and unfit for any use.

d.—PAINT FOR OUTSIDE WORK.

1. Paints for outside work are to be mixed with boiled linseed oil and the necessary quantity of patent drying or Japan varnish.

2. Black paint for outside work may be mixed with boiled linseed oil and copal or coachmaker's varnish.

3. No spirits of turpentine is to be used in mixing paints for outside work.

4. Iron work which has been neglected and rusty should be thoroughly cleaned by scraping and polishing, and then primed with one or two coats of red lead, before the paint of the required color is put on.

5. Raw linseed oil is, as a general rule, only used for priming new wood work.

e.—TO MAKE LEAD COLOR, GREY, ETC.

1. Add lampblack (or black paint, ground in oil) in small quantities to white paint, ground in oil, until the desired shade of lead color is obtained; then, if for inside work, thin it to the consistency of cream with spirits of turpentine and the patent drying or Japan varnish; if for outside work, use boiled oil for thinning, in place of the turpentine.

f.—YELLOW PAINT STRAW COLOR, BUFF, ETC.

1. For yellow paint, chrome yellow and yellow ochre are in general use.

2. For straw color or buff: to chrome yellow or yellow ochre add, in small quantities at a time, white paint (ground in oil) until the desired shade is obtained, to which a small quantity of Venetian red may be added to soften the yellow gloss.

3. For brick color, mix yellow paint, red lead, and a small quantity of white paint.

4. Oak-wood color may be made with three-fourths of white paint and one-fourth of umber and yellow ochre. The proportions of umber and yellow ochre will be determined by the desired tint.

5. Portland-stone color is made with umber, yellow, and white paint.

6. In mixing all paints, it must be remembered that the quantity of drying is to be in the same proportion, and that for inside work, or work not exposed to the weather, spirits of turpentine is to be used for thinning, and for outside work exposed to the weather oil is to be used without turpentine.

g.—DRYINGS.

1. Patent drying, paste.

2. Japan varnish, liquid.

3. Litharge, in powder.

4. When litharge is used as a drier, it must be reduced to a fine powder; then, by means of a little oil, made into a paste, and finally mixed thoroughly with the paint before using it.

h.—PAINT BRUSHES, PENCILS, ETC.

1. Paint brushes are round and flat, and of different sizes. Round brushes vary from one to two and a half inches in diameter.

2. The large paint brushes are used for putting on priming and in painting over large surfaces which require considerable quantities of color.

3. The smaller brushes are used for parts to which the larger brushes, from their size, cannot be applied.

4. Flat brushes are used for sashes, for varnishing, and for painting in lines or narrow spaces.

5. When the bristles of a brush get loose, drive a few thin wedges of wood inside of the binding twine or thread, which will render the whole fast again.

6. A different brush should be used for each color.

7. Brushes which have been used must not be left to dry with the paint in them. They should be put into a paint pot, or old paint keg, with sufficient water to come within half an inch of the binding of the brush. Care must be taken not to have too much water in the paint pot or keg, for if the binding of the brush is left in the water it will soon rot, and the brush will be useless. When short of brushes, they may be washed in oil or spirits of turpentine, and finally with soap and water, so as to render them fit for use in any color. The oil and spirits of turpentine used in washing brushes will do for mixing paint of the same color of the paint washed from the brushes.

i.—CARE OF PAINTS, ETC.

1. White paint, ground in oil, will be put up in kegs.

2. Black paint, ground in oil, will be put up in kegs.

3. Lampblack will be put up in papers, and must be kept dry.

4. Boiled linseed oil will be kept in tin cans.

5. Spirits of turpentine will be kept in tin cans.

6. Red lead will be delivered dry, and must be kept in kegs or tin, and in a dry place.

7. Dry paints of all descriptions will be put up in the best manner, and must be kept in a dry place.

8. Dryings, varnish, &c., will be kept in bottles or tins.

9. When a part of the paint is taken from a keg (ground in oil) the residue is to be covered with water to the depth of one or two inches, at least, and then the head of the keg is to be put in tightly. The paint must not be left to dry, nor exposed to the air or weather.

10. Paints, oil, spirits of turpentine, &c., must be kept under cover and in a dry place.

11. Putty will be put up and kept in bladders. It must be kept under cover, and not exposed either to the sun or weather.

12. Putty, when too hard for use, may be softened by mashing and rolling in the hands, aided by the addition of a little linseed oil.

13. To make putty: to four-fifths of pulverized Spanish whiting add one-fifth linseed oil, and work it into a paste.

j.—HINTS TO GUIDE IN PUTTING ON PAINT.

1. In painting, durability is to be the first consideration.

2. The parts to be painted must be clean, smooth, and free from grease. All holes, cracks, nail-heads, &c., must be filled in with putty. If the wood is new, the first coat should be put on thin, to serve as a priming. If new iron, then a thin coat or two of red paint should be put on as a priming.

3. A second coat of paint is never to be put on until the previous one is thoroughly dry and hard, which will never be the case whilst the least stickiness is felt on applying the hand to it.

4. Each coating of paint should be of the same thickness throughout, otherwise the work, when done, will have an unfinished and slovenly appearance.

5. Paint put on too thin, after priming, will crack in drying; if put on too thick, it will blister, wrinkle, and peel off.

6. In using the brush, where there is sufficient space, long strokes should be employed to extend the color in a smooth and uniform manner; where the space is contracted or rough, the paint should be laid on in dabs, for the purpose of getting it into the recesses and places where the surface is unequal.

7. Sash brushes and pencils should not be dipped into the paint pots, but a small quantity of the paint should be placed upon a clean board, a piece of tin, or glass, to serve as a palette; the brush or pencil can then be worked into the paint, and fine lines drawn with it; but if dipped into the paint pot, the exterior of the brush only will be covered with paint, with which it will not be possible to do nice work.

k.—WHITEWASH.

1. The following *recipe for whitewashing* has been found by experience to answer on wood, brick, and stone, nearly as well as oil paint, and is much cheaper:

2. Slake half a bushel of unslaked lime with boiling water, keeping it covered during the process. Strain it and add a peck of salt, dissolved in warm water; three pounds of ground rice put in boiling water, and

boiled to a thin paste; half a pound of powdered Spanish whiting, and a pound of clear glue, dissolved in warm water; mix these well together, and let the mixture stand for several days. Keep the wash thus prepared in a kettle or portable furnace, and when used put it on as hot as possible, with painters' or whitewash brushes.

l.—RECIPE FOR CEMENT-WASHING LIGHT-HOUSE TOWERS ON THE OUT-SIDE.

1. Take of fresh Rosendale cement three parts, clean sand one part, and mix them thoroughly with fresh water. This will give a grey or granite color, dark or light, according to the color of the cement. If a brick color is desired, add enough *Venetian red* to the mixture to produce that color. The cement, sand, and coloring matter must be mixed together. If white is desired, the walls, when new, should receive two coats of cement-wash, and then whitewash. After the work has received the first coat, a single coat every three or four years will be sufficient.

2. It is best to thoroughly dampen the wall with clean fresh water, and follow immediately after with the cement-wash. This course will prevent the bricks from absorbing the water from the wash too quickly, and will give time for the cement to set. Care must be taken to keep all the ingredients of the cement-wash well stirred during the application of it.

3. The mixture must be made as thick as it will admit of to be conveniently put on with a whitewash brush.

m.—DR. M. F. BONZANO'S RECIPE FOR PREPARING CAUSTIC POTASH LYE FOR REMOVING OIL PAINT FROM IRON.

1. Dissolve two pounds (2 pounds) of potash in a bucket of water; add about one and a half pound ($1\frac{1}{2}$ pound) of slaked lime, and stir it well.

2. With a mop apply this mixture to the paint, and after a few minutes it may be easily removed by scraping.

3. As rapidly as the old paint is scraped off rinse the iron with fresh water, and dry it. This will leave the iron clean and bright.

n.—GREEN PAINT, BLACK PAINT, COAL TAR, AND IRON WORK.

1. Hereafter no green paint will be issued to light-keepers, and *black paint* or *lampblack* will be issued only when it is required to mix with white paint to make *lead color*.

2. Refined coal tar will be issued for use on all iron-work which is not necessarily to be of another color, and no black paint is to be used where coal tar will answer in color as a substitute.

3. It has been observed that, in some cases, the green japanned pedestals of light-house illuminating apparatus have been given an unsightly and dirty appearance by the rude application of the green paint furnished to light-keepers, when the original beautiful green color, if it had been let alone, would have lasted many years, with the ordinary daily cleaning and wiping.

o.—LIGHT-HOUSE INSPECTORS AND ENGINEERS.

Light-house keepers, light-vessel keepers, and masters of tenders and supply-vessels will give their attention to the foregoing hints on the subject of mixing paints, cleaning the work, putting on the paint, and taking care of the materials and implements.

DIRECTIONS FOR CONSTRUCTING LIGHTNING-RODS.

Republished from Essays on Meteorology, by Professor JOSEPH HENRY, (Smithsonian Miscellaneous Collections,) for the use of the United States Light-house Establishment.

1st. The rod should consist of round iron, of not less than three-fourths of an inch in diameter. A larger size is preferable to a smaller one. (Ordinary gas-pipe may be employed.) Iron is preferred, because it can be readily procured, is cheap, a sufficiently good conductor, and, when of the size mentioned, cannot be melted by a discharge from the clouds. Other forms of rod, such as flat or twisted, will conduct the lightning, and in most cases answer sufficiently well. They tend, however, to give off lateral sparks from the sharp edges at the moment of the passage of the electricity through them, which might, in some cases, set fire to very combustible materials.

2d. It should be, through its whole length, in perfect metallic continuity; as many pieces should be joined together by welding as practicable, and, when other joinings are unavoidable, they should be made by screwing the parts firmly together, by coupling *ferule*, care being taken to make the upper connection of the latter with the rod water-tight by cement, solder, or paint.

3d. To secure it from rust, the rod should be covered with a coating of black paint.

4th. It should be terminated above with a single point, the cone of which should not be too acute, and to preserve it from the weather, as well as to prevent its being melted, should be encased with platinum, formed by soldering a plate of this metal, not less than a twentieth of an inch in thickness, into the form of a hollow cone. Points of this kind can be purchased of almost any mathematical instrument maker. Usually the cone of platinum, for convenience, is first attached to a brass socket, which is secured on the top of the rod, and to this plan there is no objection. The platinum casing, however, is frequently made so thin, and the cone so slender, in order to save metal, that the point is melted by a powerful discharge.

5th. The shorter and more direct the rod is in its course to the earth the better. Acute angles, made by bending the rod, and projecting points along its course, should be avoided.

6th. It should be fastened to the house by iron eyes, and may be insulated by cylinders of glass. We do not think the latter, however, of much importance, since they soon become wet by water, and, in case of a heavy discharge, are burst asunder.

7th. The rod should be connected with the earth in the most perfect

manner possible; and in cities nothing is better for this purpose than to unite it in good metallic contact with the gas-mains or large water-pipes in the streets; and, indeed, such a connection is absolutely necessary, if gas or water-pipes are within the house. Electricity, by what is called induction, acts at a distance on the perpendicular gas-pipes within a house, rendering them so highly negative, the cloud being positive, as to attract the electricity from a lightning-rod imperfectly connected with the earth, or even from the air through the roof. Damage to buildings on this account is of constant occurrence. The above connection can be made by soldering to the end of the rod a strip of copper, which, after being wrapped several times around the pipe, is permanently attached to it. Where a connection with the ground cannot be formed in the way mentioned, the rod should terminate, if possible, in a well, always containing water; and, where this arrangement is not practicable, it should terminate in a plate of iron or some other metal buried in the moist ground. It should, before it descends to the earth, be bent, so as to pass off nearly at right angles to the side of the house, and be buried in a trench, surrounded with powdered charcoal.

8th. The rod should be placed, in preference, on the west side of the house, in this latitude, and especially on the chimney from which a current of heated air ascends during the summer season.

9th. In case of a small house, a single rod may suffice, provided its point be sufficiently high above the roof; the rule being observed, that its elevation should be at least half of the distance to which its protection is expected to extend. It is safer, however, particularly in modern houses, in which a large amount of iron enters into the construction, to make the distance between two rods less than this rule would indicate, rather than more. Indeed, we see no objection to an indefinite multiplication of rods to a house, provided they are all properly connected with the ground and with each other. A building entirely enclosed, as it were, in a case of iron rods so connected with the earth, would be safe from the direct action of the lightning.

10th. When a house is covered by a metallic roof, the latter should be united, in good metallic connection, with the lightning-rods; and in this case the perpendicular pipes conveying the water from the gutters at the eaves may be made to act the part of rods, by soldering strips of copper to the metal roof and pipes above, and connecting them with the earth by plates of metal united by similar strips of copper to their lower ends, or, better, with the gas or water-pipes of the city. In this case, however, the chimneys would be unprotected, and copper lightning-rods, soldered to the roof and rising a few feet above the chimneys, would suffice to receive the discharge. We say soldered to the roof, because, if the contact was not very perfect, a greater intensity of action would take place at this point, and the metal might be burnt through by the discharge, particularly if it were thin.

11th. As a general rule, large masses of metal within the building, particularly those which have perpendicular elevation, ought to be connected with the rod. The main portion of the great building erected for the World's Exhibition at Paris was entirely surrounded by a rod of iron, from which rose at intervals a series of lightning conductors, the whole system being connected with the earth by means of four wells, one at each corner of the edifice.

The foregoing rules may serve as general guides for the erection of

lightning-rods on ordinary buildings, but for the protection of a large complex structure, consisting of several parts, a special survey should be made, and the best form of protection devised which the peculiar circumstances of the case will admit.

TREASURY DEPARTMENT,

Office Light-house Board, December, 1871.

LXXXV.—CIRCULARS CONCERNING THE LIGHT-KEEPERS.

HOSPITAL DUES.

TREASURY DEPARTMENT, *December 12, 1855.*

SIR: Your letter of the 11th instant, relative to the exaction of hospital dues from the crews of light-vessels, has been received.

In reply I have to say, that seamen serving on board light-vessels are not considered within the purview of the acts for the relief of sick and disabled seamen, and are exempt from the tax. A medicine chest should be provided on board light-vessels, but no other provision can be made whilst they remain so employed.

This opinion is founded upon the fact that their employment is not of the roving character contemplated by the act, and that whilst employed and receiving wages adequate to their support, they are not proper subjects of relief.

I am, very respectfully,

JAMES GUTHRIE,
Secretary of the Treasury.

Com'r T. A. JENKINS, U. S. N.,
Secretary Light-house Board.

EXPENDITURE RETURNS.

TREASURY DEPARTMENT,
Office Light-house Board, Washington City.

Ordered: 1. That the attention of the inspectors be called to the negligent and irregular manner in which many of the light-keepers keep their expenditure books and make up their quarterly returns of expenditures of oil and other supplies.

2. That the inspectors be instructed to have the daily expenditure returns of the light-keepers carefully examined as they are received from the keepers, and, when found to be correct, entered in the office book, before transmission to Light-house Board, and report all cases to this Board in which there is evidence of negligence in keeping the accounts of expenditures, or of any attempt to keep them by computation of time, or of quantities of oil expended.

3. That the most rigid accountability must be exacted of all persons

employed on light-house service for all public property intrusted to their care, and any failure to account satisfactorily for oil or other public property is to be promptly reported.

By order of the Light-house Board :

W. B. SHUBRICK,
Chairman.

THORNTON A. JENKINS,
W. B. FRANKLIN,
Secretaries.

—
OIL BUTTS.

TREASURY DEPARTMENT,
Office Light-house Board, June 6, 1854.

SIR: Hereafter, when oil butts are authorized to be procured for light-houses and light-vessels in your district, you will please have them constructed of the best quality xxx tin, soldered *inside* and *outside*, with bands soldered over the circular seams, with a cavity formed by a double rim to hold oil for the lid to fit in,* so as to make the butt as nearly air-tight as possible, and the braces soldered on the bottoms for strengthening them.

Each butt must be thoroughly tested with boiling water before being received or sent to a light-house.

There will be two sizes of oil butts used in the light-houses, viz: 100 gallons and 50 gallons, of the shapes, dimensions, &c., of the models and drawings furnished for your office.

There will be an air-cock and a cock for drawing off oil for each butt, and two keys for every light-station. With the view to uniformity, the cocks will be furnished by this office whenever authority is given for furnishing oil butts.

By order:

Very respectfully,

THORNTON A. JENKINS, *Secretary.*

— — —, *Light-house Inspector,* — — — *District.*

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CCXXX.—RAIN WATER AT LIGHT-HOUSE STATIONS.

TREASURY DEPARTMENT,
Office Light-house Board, Washington City.

Water contaminated with chloride of lead from salt spray resting on the leads of light-houses, &c., whence rain water is collected, is peculiar in this, that it does not lose the poisoning substance either by boiling or by exposure to the air.

To purify this water, and render it perfectly fit for all culinary and domestic purposes, it will only be necessary to put some powdered chalk or whiting into each cistern in which such rain water is collected, and to stir it up well, occasionally, after rain has fallen.

* Light-keepers must not fail to keep the cavity formed by the double rim at the top of the oil butt filled with the refuse oil, so that when the lid of the butt is on, and the air-cock closed, the butt will be air-tight.

LANTERN CURTAINS AND LENS COVERS.

TREASURY DEPARTMENT,
Office Light-house Board, Washington City, D. C.

Each light-house lantern must be provided with TWO SETS OF WHITE CURTAINS, properly fitted for easy placing and removal.

The curtains must be removed after sunset, and put up before sunrise, daily. The lens must never be left exposed to the rays of the sun by the omission of the light keeper to place either its cover over it or to have the curtains put up.

Each lens apparatus will be provided with TWO FINE WHITE LINEN COVERS. They must be made of material that is *free from all roughness, and be made according to the prescribed pattern.*

Light-keepers are required to have these lantern curtains and lens covers kept clean, and the set of curtains and lens covers not in use must be kept washed, ironed, and ready to take the place of those in use when required.

THORNTON A. JENKINS,
Secretary of the Light-house Board.

ROD LAMPS.

TREASURY DEPARTMENT,
Office Light-house Board, Washington City.

Light-house keepers will be careful to use the "Rod" or "Student's" lamp in their lenses, whenever it becomes necessary for them to remove or shift their lamps during the night, so that their lights will not be totally extinguished during the time occupied in putting in a new lamp. This duty must not be neglected under any circumstances.

Light-keepers must keep their Rod lamp in the lantern at night, with the burner or centre of the wick properly adjusted to the focus of the lens, so that as soon as the lamp is removed the Rod lamp may be placed, which will give a light sufficiently brilliant to prevent shipwreck near the light-station.

Light-keepers who are not provided with "Rod lamps," will report the fact to the Light-house Inspector of the district.

TO LIGHT-HOUSE KEEPERS.

TREASURY DEPARTMENT,
Office Light-house Board, Washington, Nov., 1861.

1. No pains have been spared to provide the light-houses and light-vessels of the United States with every article of fixture and of supply necessary to enable light-keepers to perform efficiently all the duties required of them by the printed instructions and directions for keeping bright and steady lights, and in keeping their lanterns, light-rooms, towers, and dwellings clean and neat.

2. Unless the illuminating apparatus, lamps, and lantern-glass of a

light-house are kept clean and in good condition, a good light cannot be produced, and mariners will complain.

3. The instructions require that the interior of the dome of the lantern shall be kept painted WHITE and perfectly free from soot. The interior frame of the lantern must also be kept clean and painted white.

4. The glass of the lantern must be washed as often as necessary to keep it clean and free from stains of every kind. *Linen towels only are to be used in wiping* the glass of the lens and the plate-glass of the lantern, as the finest cotton when rubbed against glass will scratch it.

5. The curtains of the lantern must be put up, or the lens cover must be put on (particularly in clear weather) before sunrise, and one or the other must protect the lamp in the lens by shutting out the sun's rays in this way during the whole day. It will be best, as a general rule, to put up the curtains before sunrise.

6. After extinguishing the light in the morning, the lens, before the operation of cleaning it is commenced, should be dusted with a feather brush to remove any dust which may have accumulated upon it, and which, if left upon it while it is cleaned with rouge and spirits of wine, will scratch and injure it.

7. As soon as the lens is thoroughly cleaned the cover should be carefully put on it, and so closed at top and bottom as to exclude all dust which might rise up in cleaning the interior of the lantern, &c.

8. The light-keepers and their assistants are provided with linen aprons to put on over their clothes while engaged in the lanterns, cleaning them and the illuminating apparatus. These aprons will be delivered to the principal keepers, who alone will be responsible for them. The assistants will retain possession of these for their use while at the light-stations, but when they leave they must turn them over to the principal keeper.

9. Each keeper and assistant will keep his own apron clean, by washing it as often as may be necessary.

10. These aprons are designed—

First. To protect the lens from being scratched or otherwise injured by brass buttons or coarse woollens and other coarse articles of the keepers' clothing coming in contact with it during the operation of cleaning.

Second. To protect the keepers' clothes while performing the cleaning duties in the lantern, &c.

11. Coarse linen or tow cleaning cloths are furnished to light-keepers to enable them to wipe up easily the dirty water that may accumulate on the lantern floor, and to keep the lantern floor clean by dampening it so as to wipe up all dust without injury to the apparatus. Also, to clean the tower stairs, &c. These cloths are to be kept clean, and when not in use hung up to dry, and are not to be used for private purposes, but exclusively for the lanterns, towers, and store-rooms.

12. The boxes provided for keeping whiting, rouge powder, &c., and the tin pans for mixing whiting and rouge, and all the other implements and tools, are to be carefully looked after. They are to be kept in a dry place, and frequently examined to see that they are in good order.

13. None of the tin boxes or other fixtures are to be taken from the light-stations. The master of the supply-vessel will fill them, without removing them, when he delivers oil and other annual supplies.

14. When files or other articles of iron or steel require to be protected against dampness, they must be carefully cleaned and a thin coating of tallow put on them.

15. Too much attention cannot be given by light-keepers to the clock-work of their mechanical lamps, and, in revolving lights, to the revolving machinery.

16. For mixing and putting on paints, and for purifying water under certain circumstances, see the instructions on these subjects, and also all placards, as well as the book of printed instructions and directions, hereinbefore given for your guidance.

17. No light-keeper can perform his duty properly who does not understand clearly the instructions and directions which are furnished to guide him in their performance.

18. A light-keeper will find a list in this book of the blank-books and blanks necessary to enable him to keep his accounts of daily expenditure and to make all his returns; all of which he will receive (through the light-house inspector of the district) by the supply-vessels when annual supplies are delivered by them, or by other means.

19. Light-keepers will be careful to see that all articles called for by the receipts are actually landed from the supply-vessels, and all articles to be put in fixed places of deposit are so to be delivered. Oil must be measured and put in the butts, and the casks returned to the vessels; and all small articles must be put into the properly-marked or labeled tin boxes, &c.

THORNTON A. JENKINS,
Secretary of the Light-house Board.

MECHANICAL SKILL OF KEEPERS.

TREASURY DEPARTMENT,
Office of the Light-house Board,
Washington, December 17, 1867.

SIR: I have the honor, by direction of this board, respectfully to recommend that instructions be issued to those superintendents of lights having charge of light-stations at which first-class fog-signals are now, or may hereafter be, established, to select and nominate, if necessary, as keepers of those stations, persons having the necessary mechanical skill.

Such qualification is deemed requisite for the reason that these fog-signals of the first class are worked by steam or hot-air engines, and, for safe, economical, and efficient service, need the care and attention of persons competent to manage such apparatus.

Very respectfully,

W. B. SHUBRICK, *Chairman.*

Hon. H. McCULLOCH,
Secretary of the Treasury.

CCXXXVI.—INSTRUCTIONS AUTHORIZED.

TREASURY DEPARTMENT, *December 18, 1867.*

SIR: You are hereby authorized to issue such instructions to superintendents of lights having charge of stations where fog-signals are or

may be established, as are recommended in your letter of the 17th instant.

I am, very respectfully,

H. McCULLOCH,
Secretary of the Treasury.

Rear-Admiral W. B. SHUBRICK, U. S. N.,
Chairman Light-house Board.

STORM-PANES OF GLASS FOR LIGHT-HOUSE LANTERNS.

TREASURY DEPARTMENT,
Office Light-house Board,
Washington, D. C., September, 1858.

1. All light-houses occupying points on the coast and in the bays and sounds frequented at certain seasons of the year by wild fowl will be provided, by direction of the Light-house Board, upon reports of engineers and inspectors on light-house duty, with the requisite number and sizes of STORM-PANES OF LANTERN GLASS, to be fitted according to the directions of the Light-house Board, to enable light-house keepers to replace *promptly at night any glass that may be broken.*

2. These storm-panes of glass will be put *on edge*, very carefully, in a box of the proper dimensions, and the panes or plates of glass separately packed within its own apartment, to prevent breakage.

3. This box must be kept by the light-house keeper in a safe place, near the lantern or trimming-room of the tower. The box containing large plate-glass *must never be laid upon its side, nor must it be removed, unless absolutely necessary* to do so, but be kept stationary in one place, if possible.

4. The necessary "FIXTURES" for securing "storm-panes" in the place of broken ones will be provided, and the engineer officer or inspector who may be charged with fitting them will explain to the light-keeper the use of the implements, and the manner of putting in the glass.

5. In performing this duty, the keeper will require the aid of all the assistant light-keepers; and in the event of there being no assistant light-keepers allowed to the light-station, then the keeper must call in the aid of his wife, or some other member of his family, to hold the plate of glass in its place against the force of the wind, while he applies the fastenings to the frame of the lantern to secure it in its position.

THORNTON A. JENKINS,
Secretary of the Light-house Board.

VISITORS.

TREASURY DEPARTMENT,
Office Light-house Board,
Washington City, Nov. 15, 1869.

Visitors will be courteously and politely received, and admitted into the tower and lantern when it will not interfere with the proper exhibition of the light; but the *principle light-keeper* is responsible for any

injury or defacement to the buildings, light-room, lamps, reflectors, refractors, glazing of the lantern, and to any other property belonging to the light-station under his charge, unless he can identify parties who may have done injury, so as to make them accountable for it.

It is therefore requested that persons who visit this light-station will be careful not to handle or touch the *illuminating apparatus*, scratch or deface the plate-glass of the lantern, cut the wood-work, or write upon the window glass or painted or whitewashed parts of the buildings, or do any other injury to the premises.

By order of the Light-house Board.

FOG-SIGNALS ON BOARD UNITED STATES LIGHT-VESSELS.

TREASURY DEPARTMENT,
Office Light-house Board,
Washington, October 5, 1858.

Notice is hereby given that on and after the 1st day of January, 1859, vessels approaching or passing light-vessels of the United States in *foggy or thick weather*, will be warned of their proximity by the alternate ringing of a *bell* and sounding of a *fog-horn* on board of the light-vessel, at intervals not exceeding five minutes.

GENERAL ORDERS, &c.

1. The curtains provided for hanging inside of the lantern glass of light-houses and light-vessels are not to be used for any other purpose, or in any other place whatever. The spare sets of curtains must be kept clean and in readiness for taking the place of those in daily use when they become soiled, and under no circumstances are they to be used in the keeper's dwelling.

2. The linen towels which are required to be furnished to light-keepers for wiping off and keeping the glass and silver-plated parts of the illuminating apparatus, and the plate glass of the lanterns clean, are not to be applied to any domestic or other private or personal purpose whatever; nor are they to be used upon the glass of the apparatus, plate-glass of the lanterns, or upon the silvered parts of the reflectors when greasy or soiled from use or accident, and especially when greasy, or hard and stiff from the accumulation of sand, dust, or dirt upon them, while wet or damp.

3. The buff, chamois, or other soft skins, furnished under the regulations of the Light-house Board, for cleaning the lenses and reflectors, are to be carefully kept, *at all times*, (when not actually in use in cleaning the illuminating apparatus,) in the service box, and the cover tightly shut down to prevent their injury from dust, sand, or dirt, and especially when they are damp. Buff skins after being wet are rough and harsh to the touch, and are no longer fit for use in cleaning glass or silver plate, and if applied to the illuminating apparatus, or plate-

glass of the lantern, after having reached that state, they will scratch or roughen, and greatly injure it. *It is, therefore, strictly forbidden to use buff or chamois skins* which have been wet or damp, or to which dust, sand, or dirt has attached while damp, for cleaning lenses, reflectors, or glass. Buff skins which are no longer fit for use in cleaning the glass of the lenses, the silver-plated parts, or the plate-glass of the lanterns, may be used in cleaning the metal work of the apparatus and utensils. Spare buff skins must be kept carefully wrapped up in paper upon which there is no printing or writing, or in clean towels or cotton cloths, and stowed away in dry closets or lockers.

4. The tin boxes containing the rouge powder and Spanish whiting are to be kept tightly closed and in a dry place on a shelf in a closet or locker.

5. The turpentine soap, required to be furnished to light-keepers, is not to be used by them or their families, or by any one else, for domestic or other private purposes, but it is to be used exclusively for washing *the lens and other apparatus covers, lantern curtains, towels, and cleaning rags, and the metal and paint-work of the apparatus and lanterns.* Soap must not be used for cleaning the glass of the apparatus or lanterns, inasmuch as the grease in it, unless washed off immediately after being used with strong lye or spirits of wine, will leave greasy stains upon it and greatly injure it.

6. Neither the glass of the lens apparatus, the plate-glass of lanterns, nor the silvered parts of the reflectors, is to be cleaned with cotton cloths, cotton rags, or other material of which cotton is a component part, under any circumstances, inasmuch as even the finest carded cotton wool, will, when rubbed upon glass or polished silver, leave scratches, which, in the case of light-house illuminating apparatus, cause serious injury to its properties of refraction and reflexion.

7. Covers for lens apparatus are required, by the orders and regulations of the Light-house Board, *to be made of fine white linen which is entirely free from knots and all other matter which, coming in contact with the glass of the lens, would scratch it,* and no other kind is allowed to be used. In any case in which this regulation has been disregarded, the light-keeper will report it to the Light-house Inspector, who will see that proper *linen covers* are provided and used. Light-house Inspectors will, when making inspections of the lights, give their particular attention to this subject.

8. Keepers' aprons, made of suitable linen, are provided for all light-keepers, to be worn while cleaning the apparatus, lighting and extinguishing the light, and generally when employed in the lantern, to protect the apparatus from injury from contact of coarse clothing, metal buttons, &c. *Keepers must not disregard this order.*

9. Tripoli powders, tripoli soap, and all other cleaning materials of a similar kind, which might, through ignorance or otherwise, be improperly used upon illuminating apparatus and plate-glass of lanterns, to their great injury, *are strictly forbidden to be purchased, delivered to light-keepers, or permitted to be used by them,* and all articles of the sort or description which may be found at any light-station, by any light-house engineer, inspector, lampist, or master of a tender or supply-vessel, must be removed by them immediately, and all the facts in regard to their introduction reported for the information and action of the Light-house Board.

10. *Regulator or Damper.*—The object and use of the regulator or damper (the proper management of which is indispensable to the pro-

duction of a clear, steady, and uniformly brilliant light from the light-house lamps in use) does not appear to be well understood by many of the light-keepers who have been interrogated in regard to them, although the use is explained in the printed regulations. In all light-house lamps the regulator or damper requires to be used intelligently, *opening or closing the tube by use of the key*, in lighting, and attending upon the light so as to regulate the draught, as the glass chimney is adjusted to the height of the flame and the wick is gradually raised to get the flame up to its greatest attainable (normal) height, while free from jagged and smoky points; but in those lamps having the oil cisterns placed above the apparatus, (the Hydraulic, Franklin, and Float lamps, &c.) this regulator or damper, having the key regulating the disk (placed inside the tube) above the oil cistern, answers the double purpose of *regulating the draught and also of retaining much of the heat from the flame* in that part of the pipe or tube in the immediate vicinity of the oil, keeping it even in very cold weather in a fit state for burning without the necessity for resorting to heaters to accomplish that purpose. Most light-keepers seem to think that the sole object of the regulator or damper is to keep the oil fluid in cold weather; and, consequently, it has been thrown aside in many instances during warm weather, and, as a rule, some have not used it at all. Inspectors are instructed to interrogate light-keepers particularly on this subject; see that the regulator or damper (and a spare one in every instance) is provided and in good order, and that the tube is long enough to reach *well up* in the dome of the lantern, or into the "cowl," so that the smoke and gases from the lamp may be carried off through the "cowl" at the top of the lantern; and lampists, when visiting lights to repair lamps, &c., will carry out this instruction and report promptly any want of conformity to, or departure from, these requirements, remedying at the time such defects as may be in his power, especially with regard to the length of the tube, its capacity for the easy introduction of the glass chimney into the lower part of it, the easy working of the disk of the key, &c.

11. *Glass Chimneys*.—Glass chimneys have been found at some of the light-stations which were not of the shape, length, or of the quality of glass prescribed and required by the Light-house Board Regulations. The drawings to be found in the Light-house Board portfolio, showing the shape, size, length, &c., and the specimens furnished to the inspectors of each light-house district as models and patterns, have not been conformed to in some instances, and, so far, to the injury of the lights at which these inferior chimneys have been used.

12. The ruby or red-glass chimneys, used for distinction in some of the small lights, have been found (in nearly every instance where examined) to be far inferior in quality and color to what they should have been. As the lightest, clearest, and best-made red or pink glass chimney absorbs a large part of the white light over which it is placed, it is the duty of inspectors to see that none are used but those which will, while imparting the necessary red color to the light for distinction, are not so thick and black, or dark, as unnecessarily to absorb the light and impair its usefulness at times and in certain states of the atmosphere, when it is of the greatest importance to the mariner to see it at certain distances, and outside of dangers. All chimneys for use in the United States Light-house Establishment are required to be made according to the patterns or models of those used in the French Light-house Establishment; to be carefully inspected by experts before being received or paid for, and by which inspection it is to be satisfactorily

seen that they are uniform in shape, length, and thickness; free from striated or wavy appearances and other obvious defects which any careful expert would not fail to detect; and that their bottoms are ground to fit the holder; and, finally, it must be satisfactorily shown that they have all passed carefully through the annealing process at the manufactory.

13. Inspectors are hereby instructed to carefully examine the glass chimneys on hand when they visit light-stations, and to instruct the lampists to do the same, and to have all of those which may be found not suited to the light-house service, and not in strict conformity to the regulations, removed, to be disposed of as unfit for use, as the board may from time to time direct; and those of the quality and kind prescribed by the regulations will, upon requisitions from the inspectors, be ordered and sent from the manufactory after having been properly inspected and accepted by an inspector or other competent and reliable person.

14. Light-keepers are required to put aside all articles of supply, all implements, tools, worn-out articles, &c., which are in excess or not necessary for the proper management of their lights, and when the tender or supply-vessel visits the light-station, to deliver them up and take receipts for the same in duplicate, one copy for file and the other to be sent to the light-house inspector of the district.

15. Masters of tenders will receive, receipt for, and deliver into depot all surplus articles found at light-stations.

16. Masters of supply-vessels will be careful to see that all unnecessary articles are taken on board and delivered at the depot, receipting for them to the keeper.

17. *Delivery of Supplies.*—The supplies are not to be left on the beach or elsewhere than in the light-houses and on board of the light-vessels. The oil will be put into the oil butts by the crew of the supply-vessels, and all casks, &c., taken back to the vessel. As the contents of the two sizes of oil butts (100-gallon and the 50-gallon) are uniform and fixed, they will be the kind for receiving and delivering into, and thereby prevent the complaints of the quantity of oil delivered being less than that receipted for, as sometimes happens.

These orders are to be furnished to all light-keepers, masters of supply-vessels, light-house tenders and other employés, and officers on light-house duty.

By order of the Light-house Board:

W. B. SHUBRICK,
Rear-Admiral, U. S. Navy, Chairman.

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| THORNTON A. JENKINS, <i>Rear-Admiral, U. S. Navy.</i> | } <i>Secretaries.</i> |
| GEORGE H. ELLIOT, <i>Maj. of Engineers, U. S. A.</i> | |

TREASURY DEPARTMENT,
Office Light-House Board,
Washington, D. C., September, 1871.

GENERAL ORDER.

At a regular quarterly meeting of this board, held September 5, 1870, it was—

Ordered, 1. That pressed or mould-glass lenses and lanterns, or lamps fitted with solid (capillary) wicks, are not to be used in the Light-house Establishment at any station at which a light of greater power than a hand-lantern, hoisted to a post or stake, is required; but in all cases where range, pier head, stake, or other lights, which ought to be seen at a greater distance than one or one and a half miles the burner of the lamp used must be an Argand, and fitted to a polished glass lens (steamer's French lens) of the proper arc; or, if not available, a 21-inch parabolic reflector, fitted with an Argand fountain lamp.

2. That range-line lights are to be both white or both red for the same range line, so that both lights may be as nearly as possible of the same power; and at those light-stations, otherwise properly distinguished, at which there is but one range line of two lights, white will be the distinction of both lights; at ports or places or in neighborhoods where there are several range lines, each marked by two lights, the most prominent, or first seen, should be both white; the next, or middle, both red; the next, both white, &c.

Red should be used only when other or better means of distinction are not available, as in cases where there are several sets of lights to mark different range lines in the same vicinity, or where there are several piers in the same port upon which lights are placed, rendering their characteristic distinction, by color or otherwise, necessary.

When red chimneys or red shades are required to be used, to make the distinction of red at any particular place, the apparatus and lamp should be of greater power than it would be if the light were of its natural color.

The red chimneys, or red shades, (as the case may be,) must be of the *best quality of glass, and of pure color*; and under no circumstances should the glass be thicker than white would be, or the color darker than necessary to produce the required shade. Red lights should be compared frequently with white ones while inspecting, and distances noted at which each of the same order and under similar circumstances can be seen.

W. B. SHUBRICK,
Rear-Admiral, U. S. Navy, Chairman.

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| THORNTON A. JENKINS, <i>Rear-Admiral, U. S. Navy,</i> | } <i>Secretaries.</i> |
| GEORGE H. ELLIOT, <i>Major of Engineers, U. S. Army,</i> | |

TREASURY DEPARTMENT,
Office Light-house Board, Washington, D. C.

GENERAL ORDER.

At a regular quarterly meeting of this board, held September 5, 1870, it was—

Ordered, That a general order be issued forbidding the issue and use, in the light-house service, of Tripoli powder, Tripoli soap, and all other

kindred articles which, in the hands of ignorant or careless keepers, might seriously injure and impair the usefulness of the illuminating apparatus.

W. B. SHUBRICK,
Rear-Admiral, U. S. Navy, Chairman.

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|---|----------------|
| THORNTON A. JENKINS, <i>Rear-Admiral, U. S. Navy,</i> | } Secretaries. |
| GEORGE H. ELLIOT, <i>Major of Engineers, U. S. Army,</i> | |

TREASURY DEPARTMENT,
Office Light-house Board, Washington, D. C.

GENERAL ORDER.

At a regular quarterly meeting of this board, held September 5, 1870, it was—

Ordered, That a general order be prepared and issued to light-house inspectors defining, as much in detail as possible, the kinds and sizes of boats for the different light-stations at which boats are allowed by the regulations of the board, and at which they may be specially authorized to provide them.

1. That no boat is to be furnished to any light-house or light-vessel which is not specially suited to the official wants of the station, and which (if for a light-house) one man may safely handle, in case there is but one keeper, and two men may safely manage, if there is an assistant keeper, in ordinary weather.

2. That the boats shall be well built and properly fitted, in a substantial and economical manner, without useless or unnecessarily expensive outfits.

3. That no boat be allowed at any light-station which the keeper or keepers (as the case may be) may not be able to easily keep out of danger, by hauling or hoisting up when not in use.

4. That light-keepers who neglect their boats be required to pay the cost of all repairs growing out of such neglect, and, in case the boats are not indispensable appendages to the light-stations, that the keepers be deprived of them if, after having been once admonished to take better care of the public property, they fail to do so.

W. B. SHUBRICK,
Rear-Admiral, U. S. Navy, Chairman.

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| THORNTON A. JENKINS, <i>Rear-Admiral, U. S. Navy,</i> | } Secretaries. |
| GEORGE S. ELLIOT, <i>Major of Engineers, U. S. Army,</i> | |

TREASURY DEPARTMENT,
Office Light-house Board, Washington, D. C.

Placard to be kept hung up at all light-stations where boats are furnished.

GENERAL ORDER.

The attention of light-house inspectors, and of all light-keepers who are provided with boats by the Light-house Board, is called to the extracts from the printed regulations and instructions which follow :

BOATS.

1. The boats allowed at special light-stations and on board of light-vessels to enable the light-keepers to perform their public duties properly, and to procure provisions for their families, are not provided for their mere personal benefit and convenience, or as an addition to or a part of their compensation, but as a necessary appendage to the particular light-station to enable the keeper to communicate with points only to be reached by water; and keepers who are furnished boats are prohibited from using them for any other than the above-mentioned purposes; and especially are they prohibited from using, lending, or hiring the boats thus placed under their charge for freighting or wrecking goods, wares, or merchandise, or for fishing with seines, ferrying, or for taking passengers for a pecuniary consideration.

2. As a general rule, boats will not be allowed to light-houses on the mainland.

3. In the selection of boats for those light-stations coming within the rule allowing them, special care is required to be taken to prevent those not suited to the special public wants of the station, and the character of the service, being furnished.

4. Any keeper, in disregard of these requirements, who allows the boat furnished to his station to be lost or injured by neglect, or improperly used or injured by others, will be required to make good all damage at his own cost and expense.

5. Inspectors are required to be careful not to furnish any boat when authorized by the board that it is not suited in size and description to the prescribed uses for the particular light-station. At stations with but one keeper, the boat should be such as one man may safely manage in ordinary weather; and at stations with two or more keepers, boats should be such as one man may safely manage in ordinary weather, and two men in bad weather.

6. The dimensions and descriptions of boats for light-vessels must be determined with regard to the use to be made of them, the distance the vessel lies from the nearest safe landing, the character of the weather which may be ordinarily encountered by them, and the number of men available for their management. Large and expensive sail-boats are forbidden to be furnished to either light-vessels or light-house stations.

As a rule, for light-house stations, *the boats should be light*, to be pulled with two or four short and light oars, and from fifteen to twenty feet long, fitted with one mast and sail, such as one man, or at most two men, could readily manage in any weather that a boat should be out in.

Keepers who neglect to haul up their boats out of the reach of surf, when not in use, and to otherwise properly care for and keep them in good

order, will subject themselves to the penalty of having to pay for all repairs caused by such neglect, may be deprived of the use of a Government boat, and also recommended for dismissal.

By order of the Light-house Board :

W. B. SHUBRICK,
Rear-Admiral, U. S. N., Chairman.

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|---|-----------------------|
| THORNTON A. JENKINS, <i>Rear-Admiral, U. S. Navy,</i> | } <i>Secretaries.</i> |
| GEORGE H. ELLIOT, <i>Major of Engineers, U. S. A.,</i> | |

TREASURY DEPARTMENT,
Washington, D. C., Sept. 5, 1870.

GENERAL ORDER.

At a regular quarterly meeting of this board, held September 5, 1870, it was—

Ordered, That when lights are established on new sites, or at new stations, the grounds, as far as may be practicable, shall be graded, cleared up, and suitably enclosed; and that at old or existing light-stations, when extensive repairs or renovations are to be made, or when it may be practicable to send the necessary material or labor, the estimates shall include the necessary cost of having the grounds properly graded and cleared of old buildings, &c., as far as possible, and the enclosures left in proper condition.

At light-stations having too great an extent or area of grounds for proper enclosure at reasonable cost, and as a protection to the light-house buildings, proper enclosure of a reasonable quantity of land, *around the buildings only*, should be estimated for. All enclosures must be adapted to the particular localities, and be constructed of plain materials, substantially put together.

The planting of shade trees and shrubbery, to serve as a protection to the grounds and buildings, must receive proper attention from engineers and inspectors, and their renewal or increase in number from time to time be estimated for and reports submitted in regard to them.

Keepers are to be encouraged to cultivate such portion of the land embraced in the light-house sites as may be adapted to profitable cultivation; but, whether they cultivate the land or not, they are to be required to keep the grounds around and about the light-houses in as good condition as their character will allow.

Weeds, high grass, and undergrowth of every description, (except such as are ornamental to the grounds,) not planted and cultivated as a protection to them, are to be kept removed from around the light-house buildings.

The special attention of inspectors and engineers is called to this subject, and they are required to make special reports and submit special estimates from time to time of proposed or recommended improvements of light-house premises, with the view to the gradual enclosing and improving of all light-stations; and those light-keepers who do not employ the time not necessarily occupied by them for other duties

in keeping their buildings and grounds in proper order, and in improving the latter as far as they can do so, must be reported to the Light-house Board.

W. B. SHUBRICK,
Rear-Admiral, U. S. Navy, Chairman.

| | |
|---|-----------------------|
| THORNTON A. JENKINS, <i>Rear-Admiral, U. S. Navy,</i> | } <i>Secretaries.</i> |
| GEORGE H. ELLIOT, <i>Major of Engineers, U. S. Army,</i> | |

TREASURY DEPARTMENT,
Office Light-house Board, Washington, D. C.

Placard to be kept hung up in the sitting-room or main hall of the keeper's dwelling.

DWELLING, TOWER, GROUNDS, BOAT-SHEDS, BOATWAYS, AND ANY AND ALL BUILDINGS AND PROPERTY AT LIGHT-HOUSE SITES.

Keepers are required to keep the grounds around the light-house towers, dwellings, and other buildings in their charge, in neat and proper order. Slovenliness will not be tolerated. In case the land is adapted to cultivation, the keepers are expected to cultivate it, and if enclosed to keep the enclosures in good order. The grounds about the house and tower are to be kept free from shrubs, bushes, weeds, old barrels, pieces of plank, boxes, &c., and the yard or immediate surroundings of the buildings must be kept cleared of all such articles, and in good order at all times. These duties are no less incumbent upon the keepers than those prescribed for keeping the light burning, apparatus clean, &c.

Those keepers who exhibit a proper zeal and industry, and who seem to desire to put and keep their grounds in good order by attending to their cultivation and enclosure, &c., will be aided as far as possible by the Light-house Board officers, in effecting necessary improvements upon the premises, by planting shade trees, making walks, repairing fences, &c., but those keepers who show no disposition to improve the grounds, and keep them and the buildings in proper order, may expect to be reported by light-house engineer officers and light-house inspectors for neglect of duty.

By order of the Light-house Board:

W. B. SHUBRICK,
Rear-Admiral, U. S. Navy, Chairman.

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|---|-----------------------|
| THORNTON A. JENKINS, <i>Rear-Admiral, U. S. N.,</i> | } <i>Secretaries.</i> |
| GEORGE H. ELLIOT, <i>Major of Engineers, U. S. A.,</i> | |

TREASURY DEPARTMENT,
Office Light-house Board,
Washington City, September 5, 1870.

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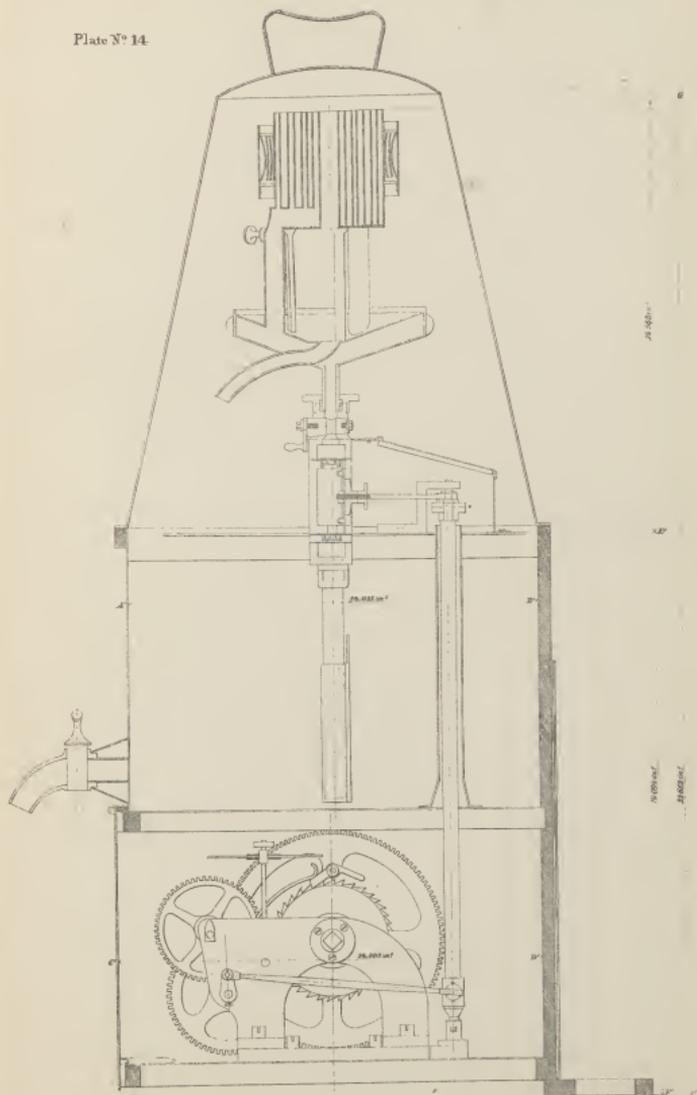
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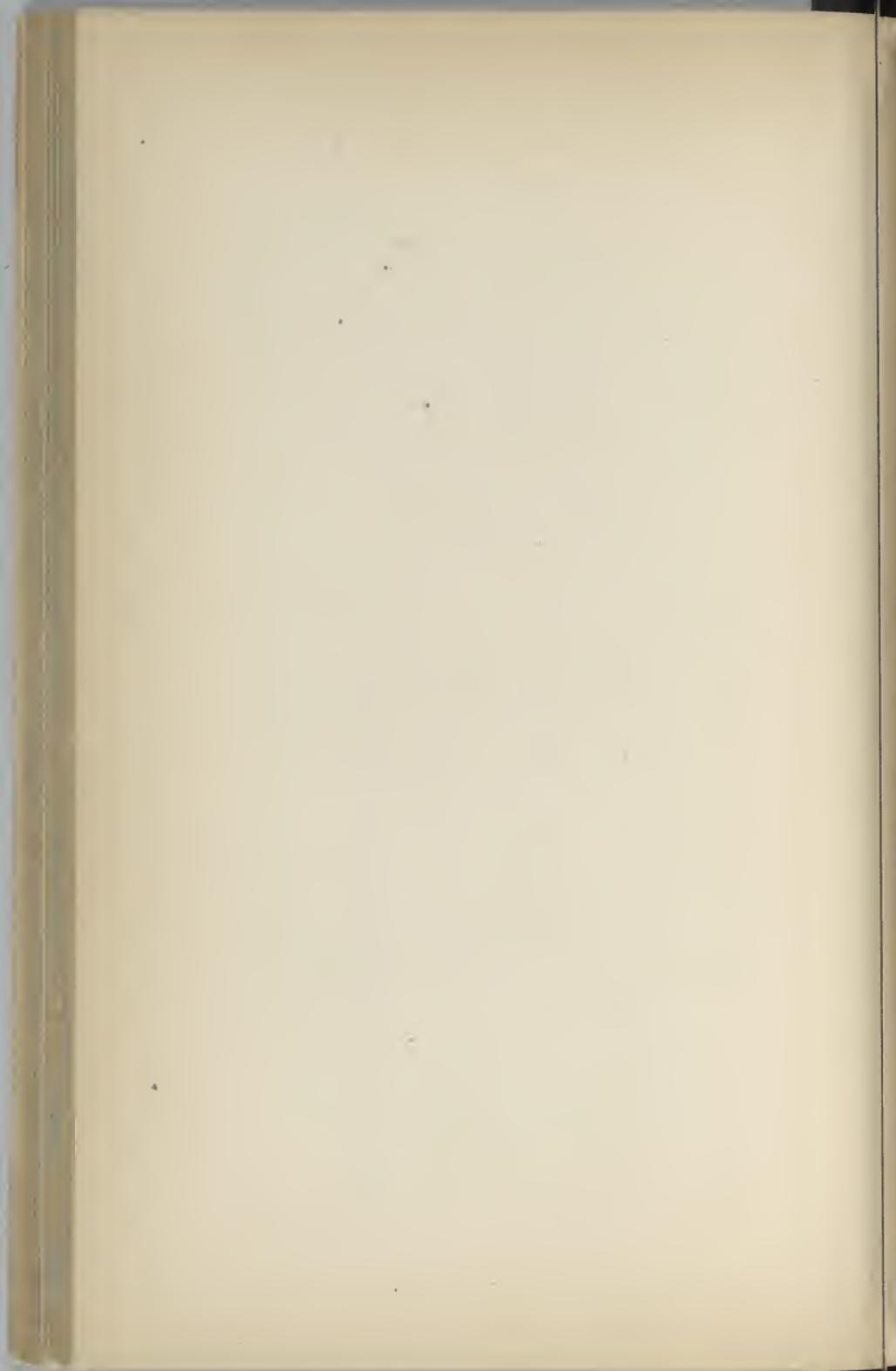
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FIRST ORDER MECHANICAL LAMP

Fig. 1.

Plate N° 14

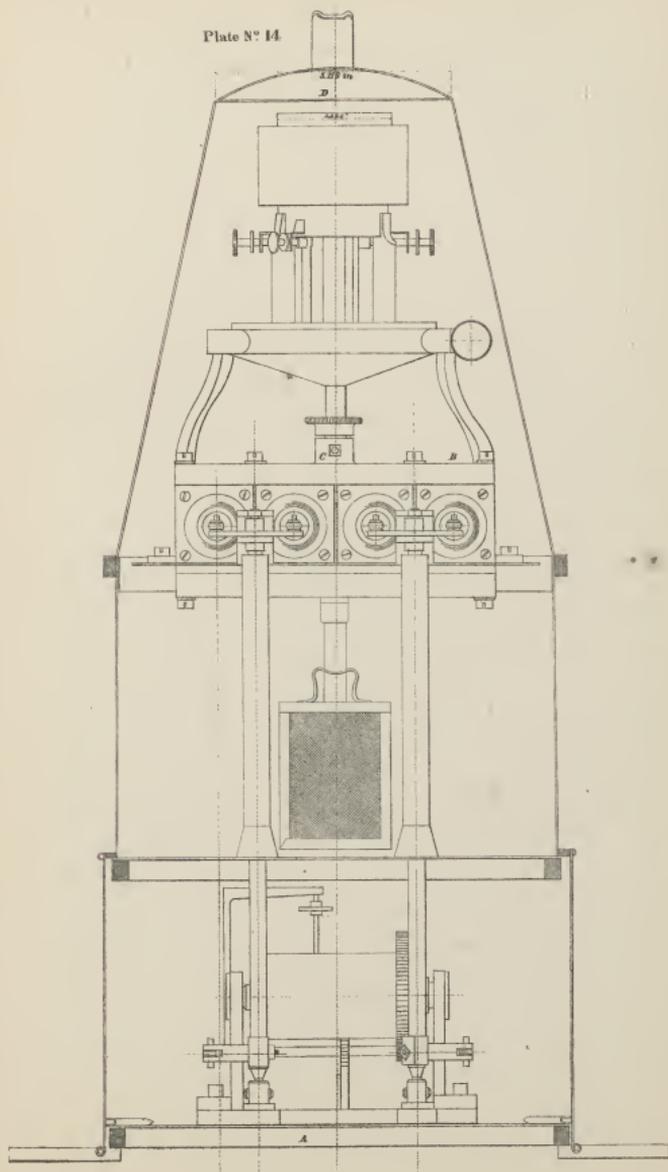


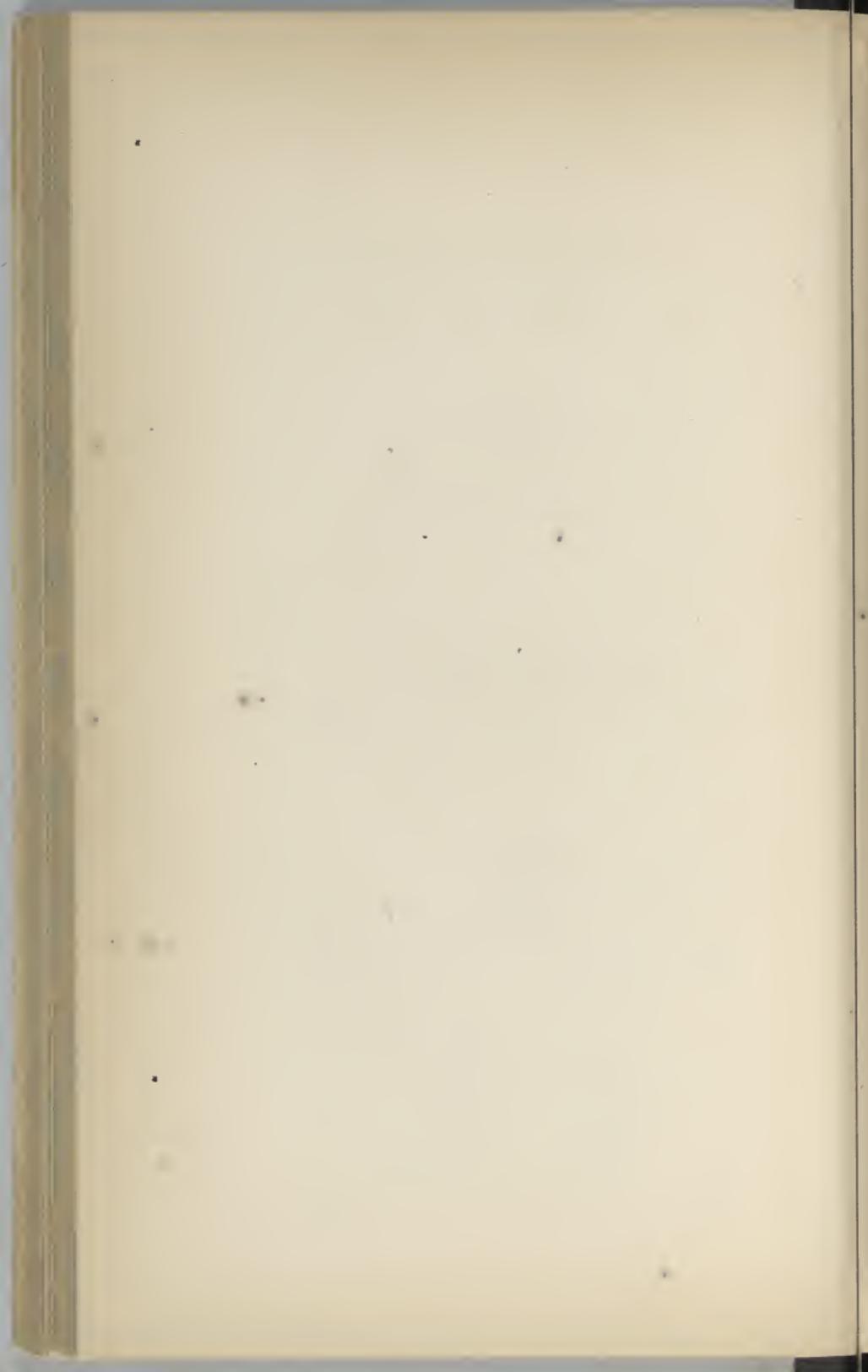


FIRST ORDER MECHANICAL LAMP.

Fig. 2.

Plate N° 14

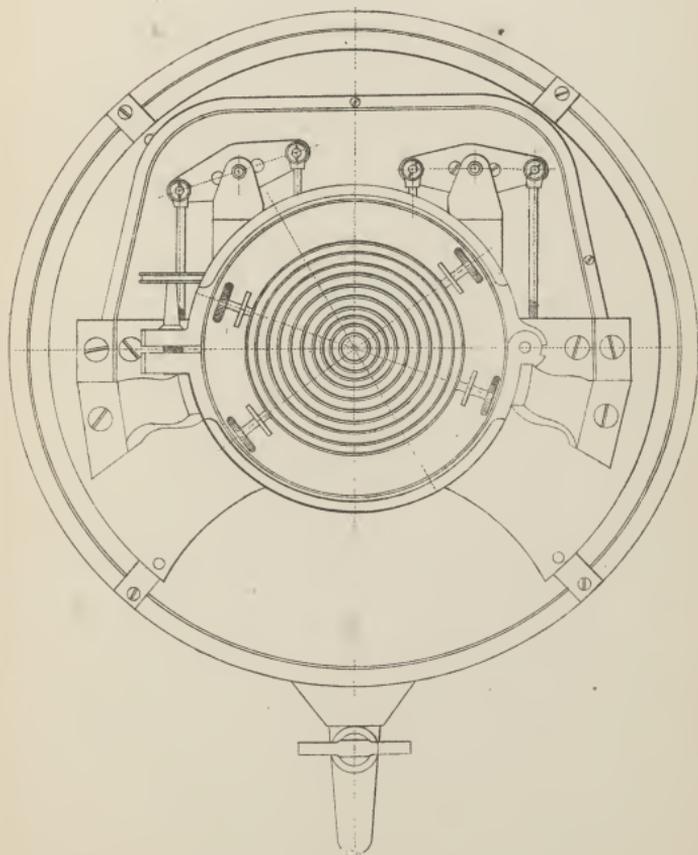


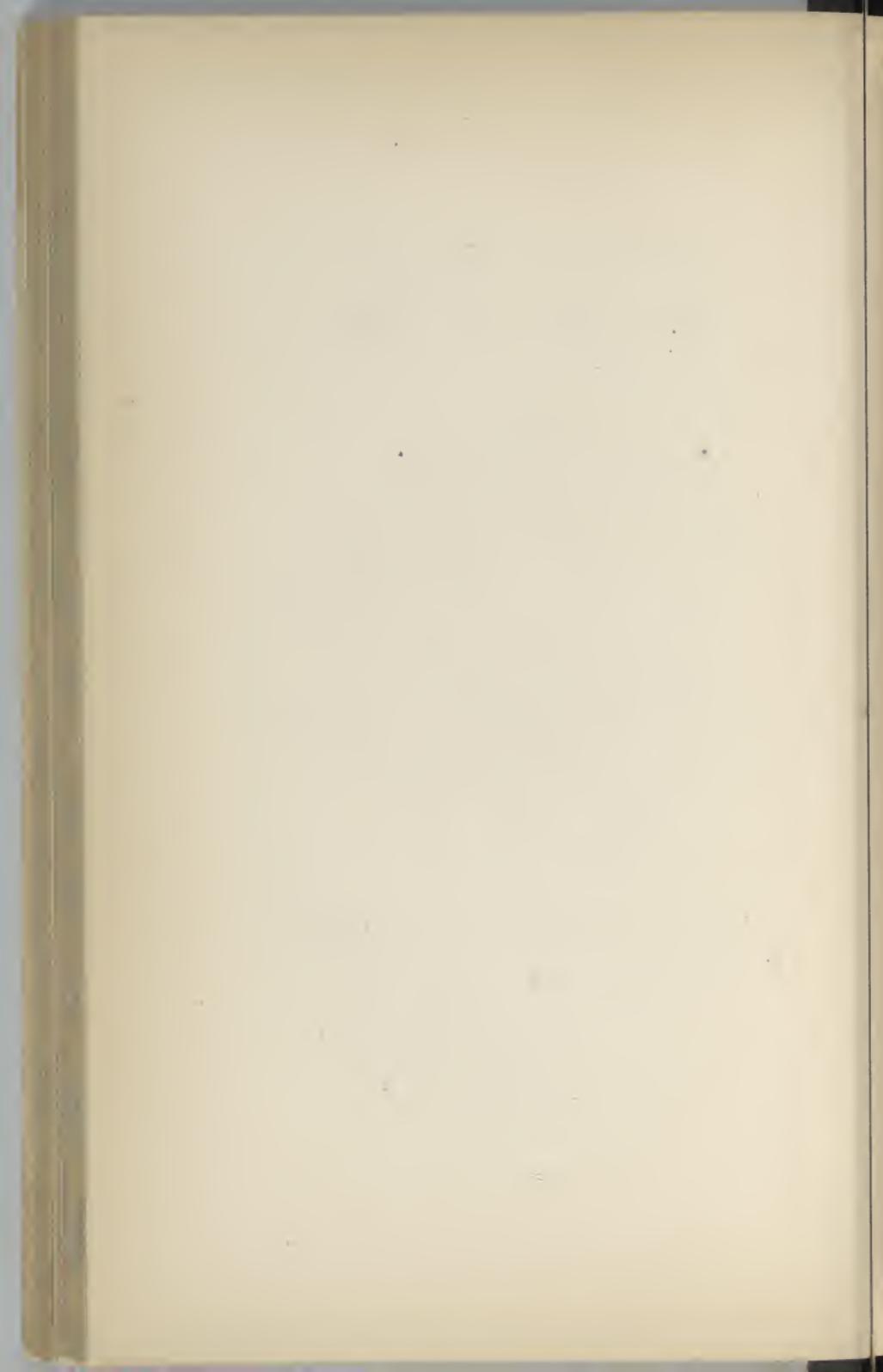


DIMENSIONS OF SECOND AND THIRD ORDER LAMPS

| SECOND ORDER | | THIRD ORDER | |
|-------------------|----------------|--------------------|----------------|
| <i>A B'</i> | 11.810 inches. | <i>A' B'</i> | 9.450 inches. |
| <i>C D'</i> | 12.000 inches. | <i>C' D'</i> | 10.040 inches. |
| <i>E F'</i> | 14.360 inches. | <i>E' F'</i> | 16.141 inches. |
| <i>G H'</i> | 33.267 inches. | <i>G' H'</i> | 27.165 inches. |

Fig. 3.





LEPAUTE'S ESCAPEMENT LAMP.

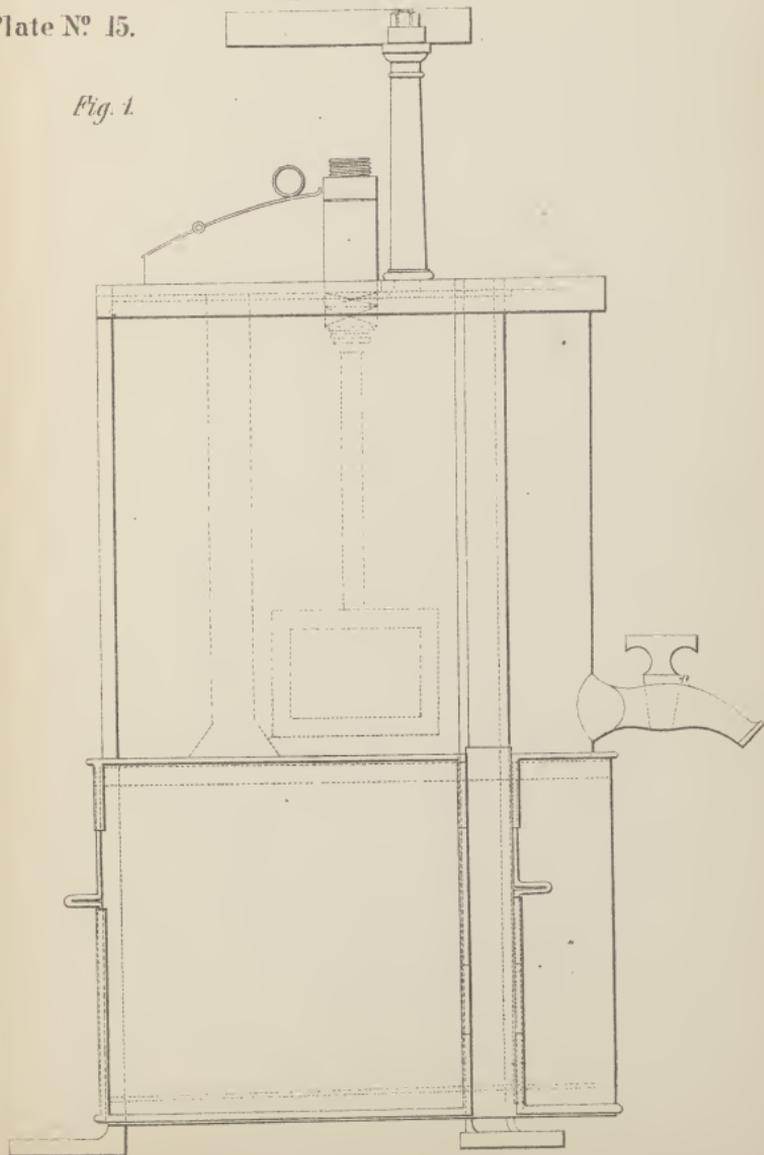
3^d. Order.

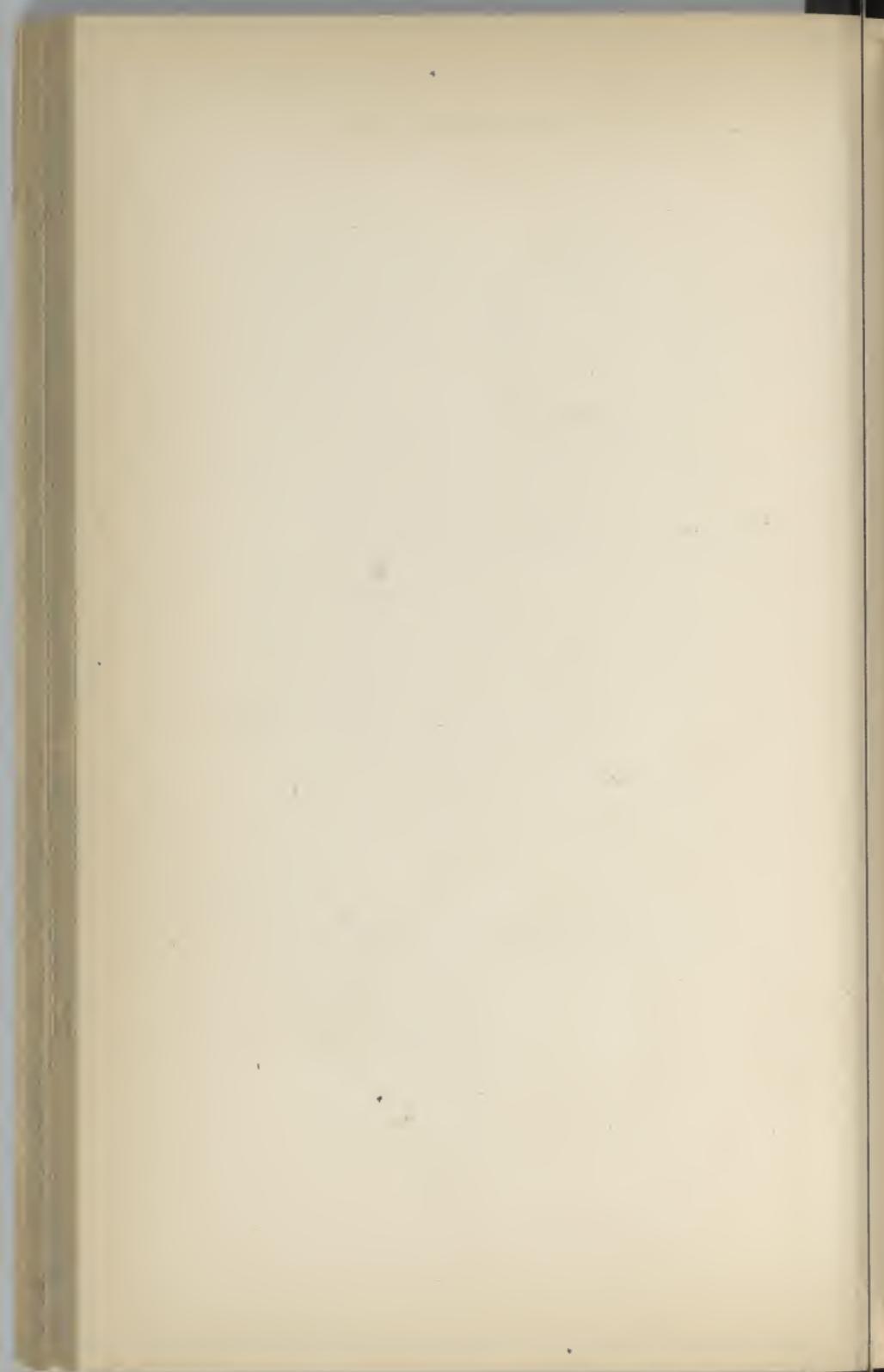
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Elevation.

Plate N^o 15.

Fig. 1.

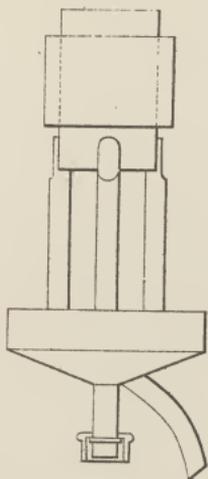




LEPAUTE'S ESCAPEMENT LAMP.

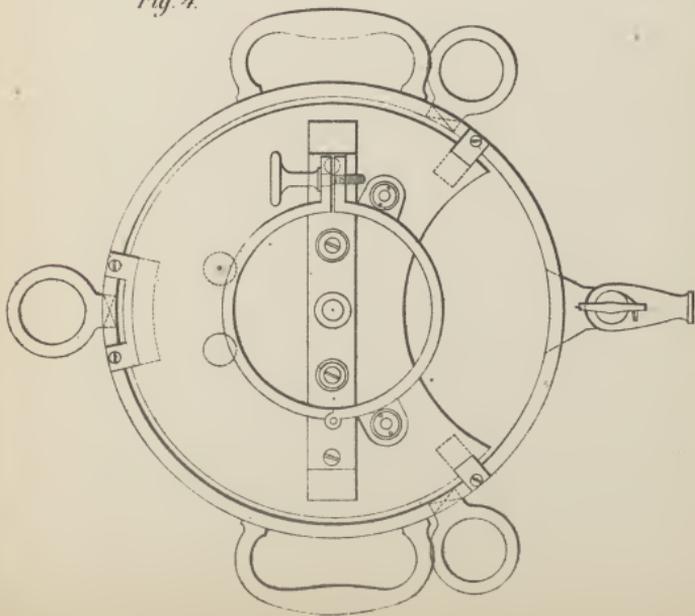
3^d. Order.

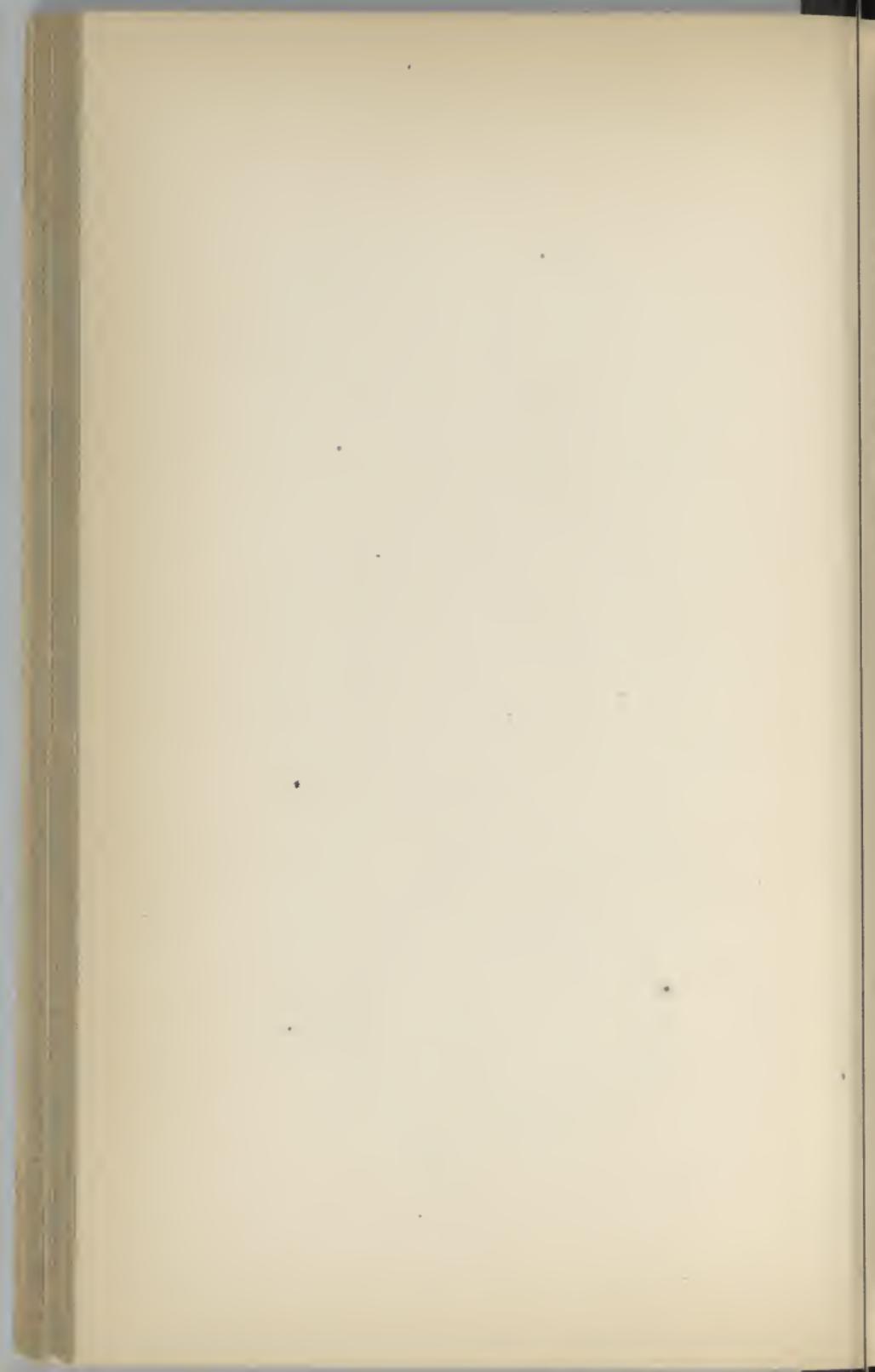
Fig. 2.



Plan.

Fig. 4.





LEPAUTE'S ESCAPEMENT LAMP.

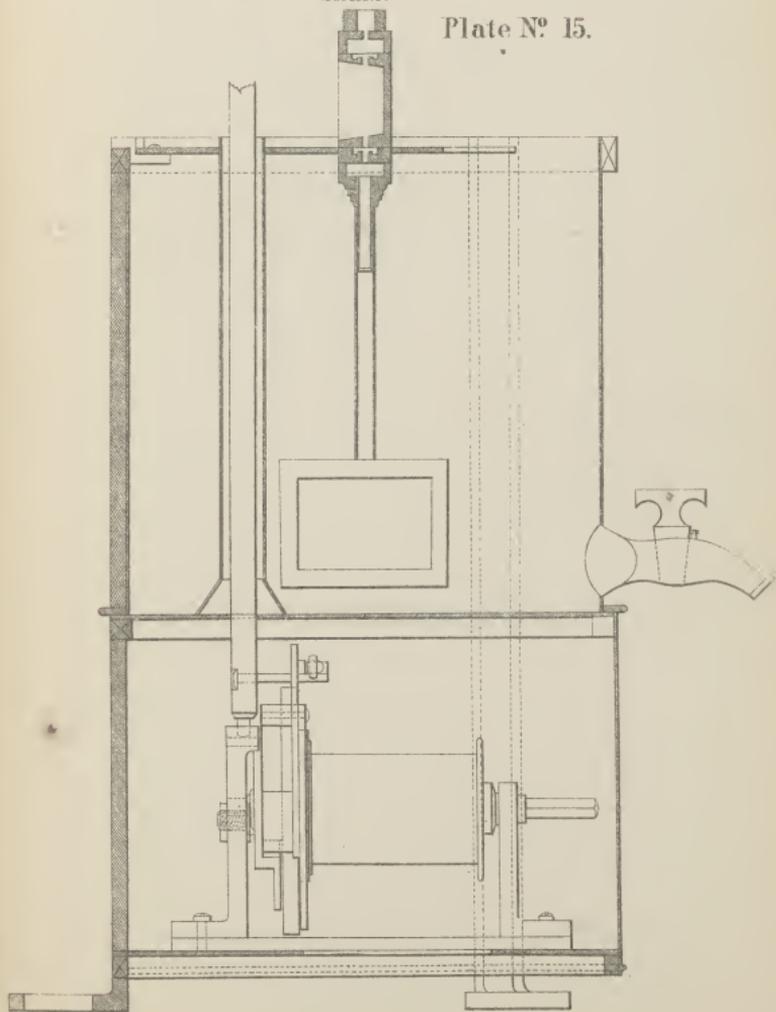
3^d. Order.

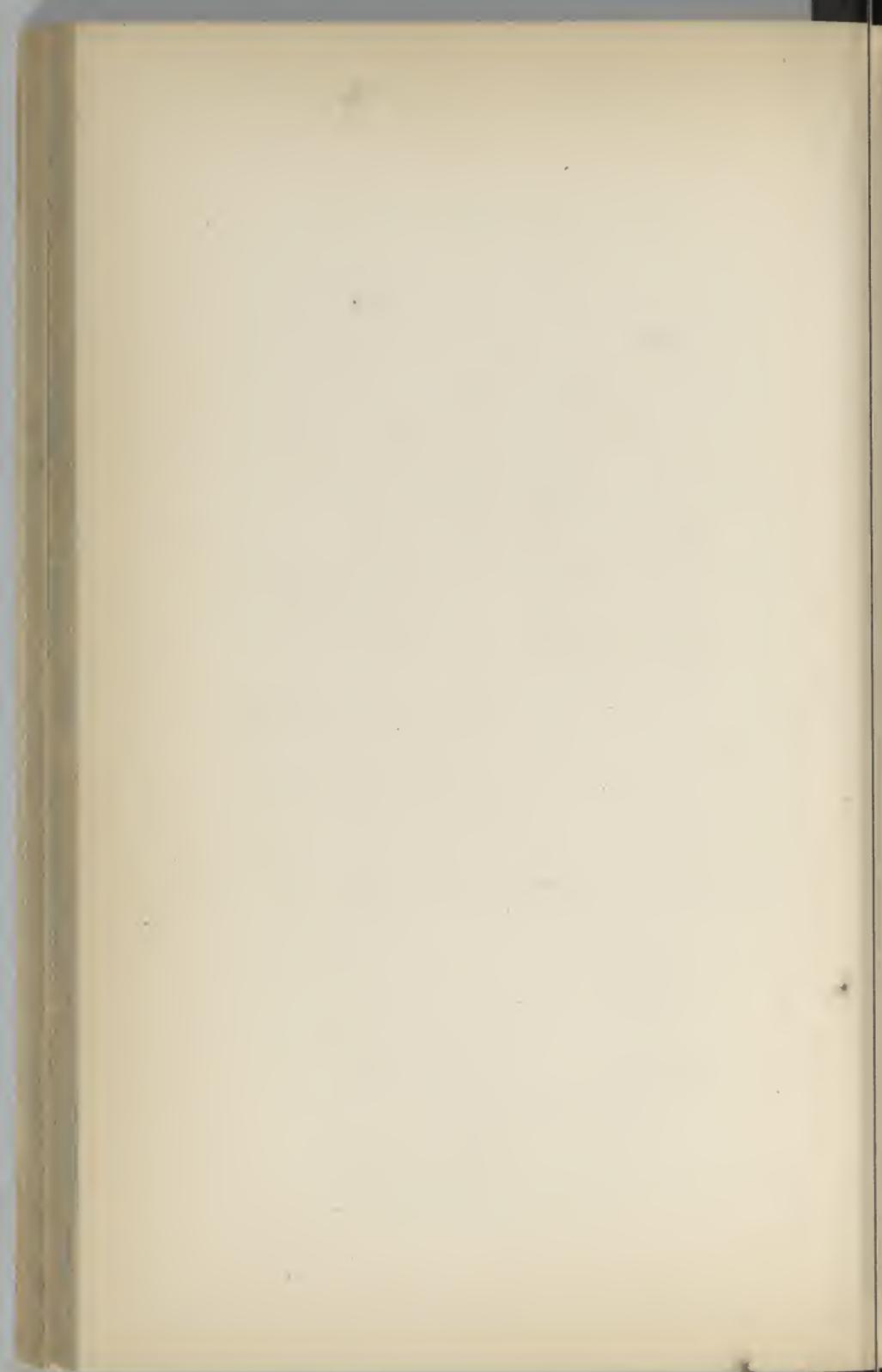
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Fig. 3.

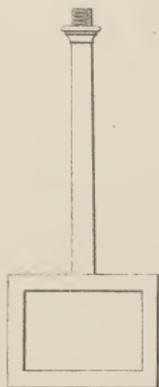
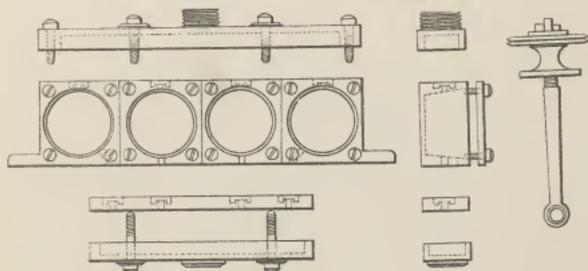
Section.

Plate N^o 15.



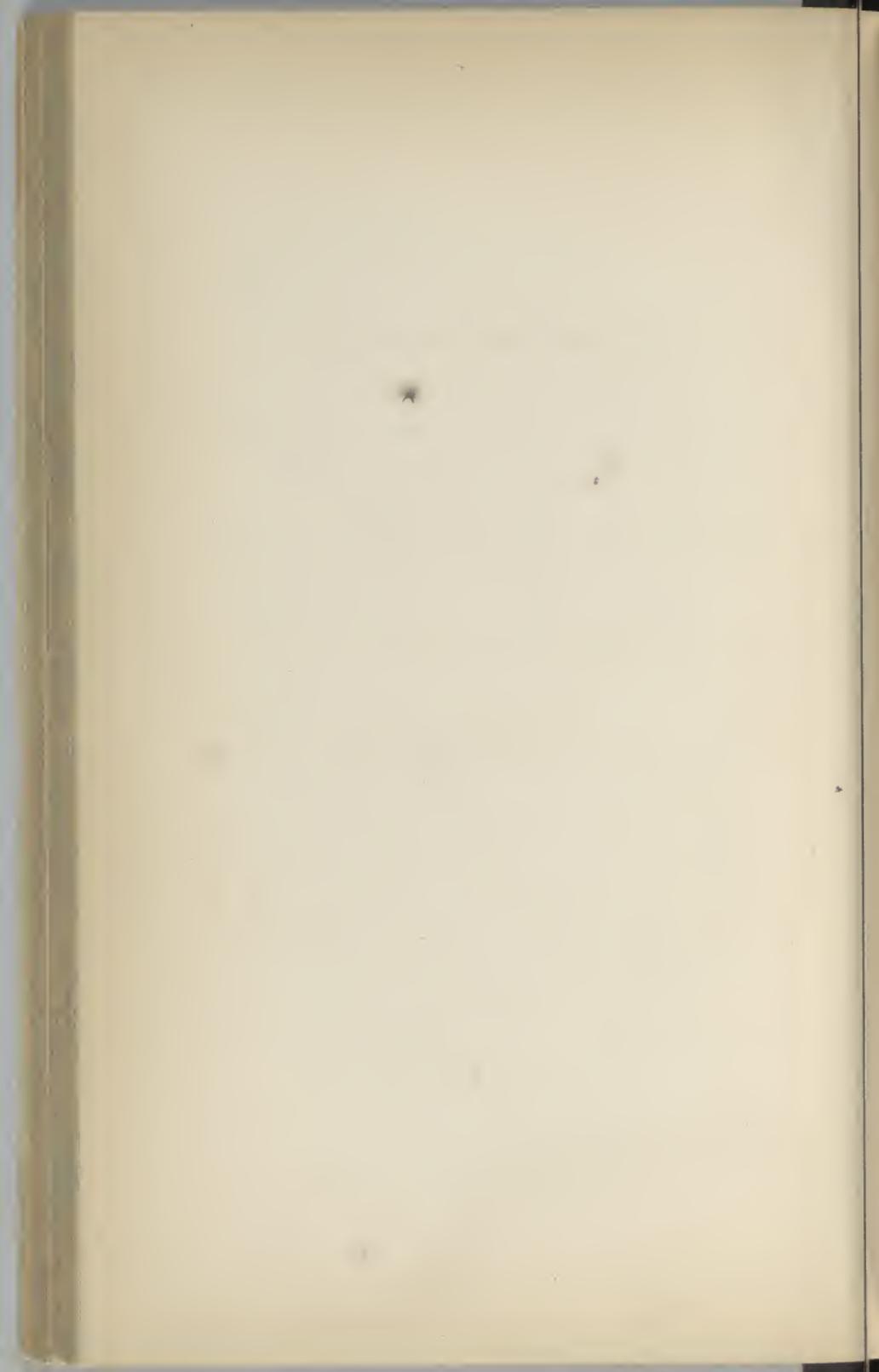


Parts of the Pump. Fig. 5.



NOTE

| | | |
|--|--|-----------------------|
| First Order Lamp. | } Height, from lower surface of supporting rings, to crown of burner, 34 inches. | |
| Exterior diameter of cylinder, above the oil cock. | | 14.5 in. ^s |
| Diameter of Burner. | | 3.6 in. ^s |
| Second Order Lamp. | } Height, (as above) . . . 34 inches | |
| Exterior diameter. | | 13 in. ^s |
| Diameter of Burner. | | 3 in. ^s |

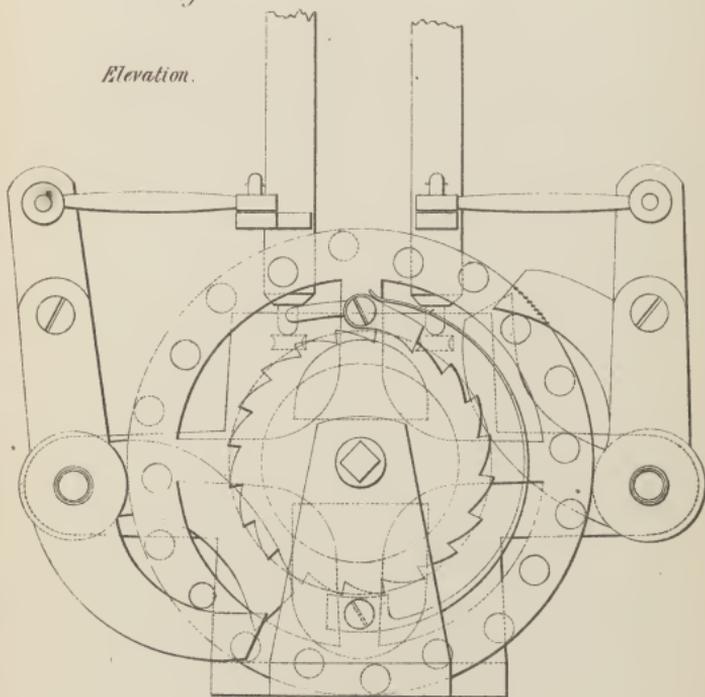


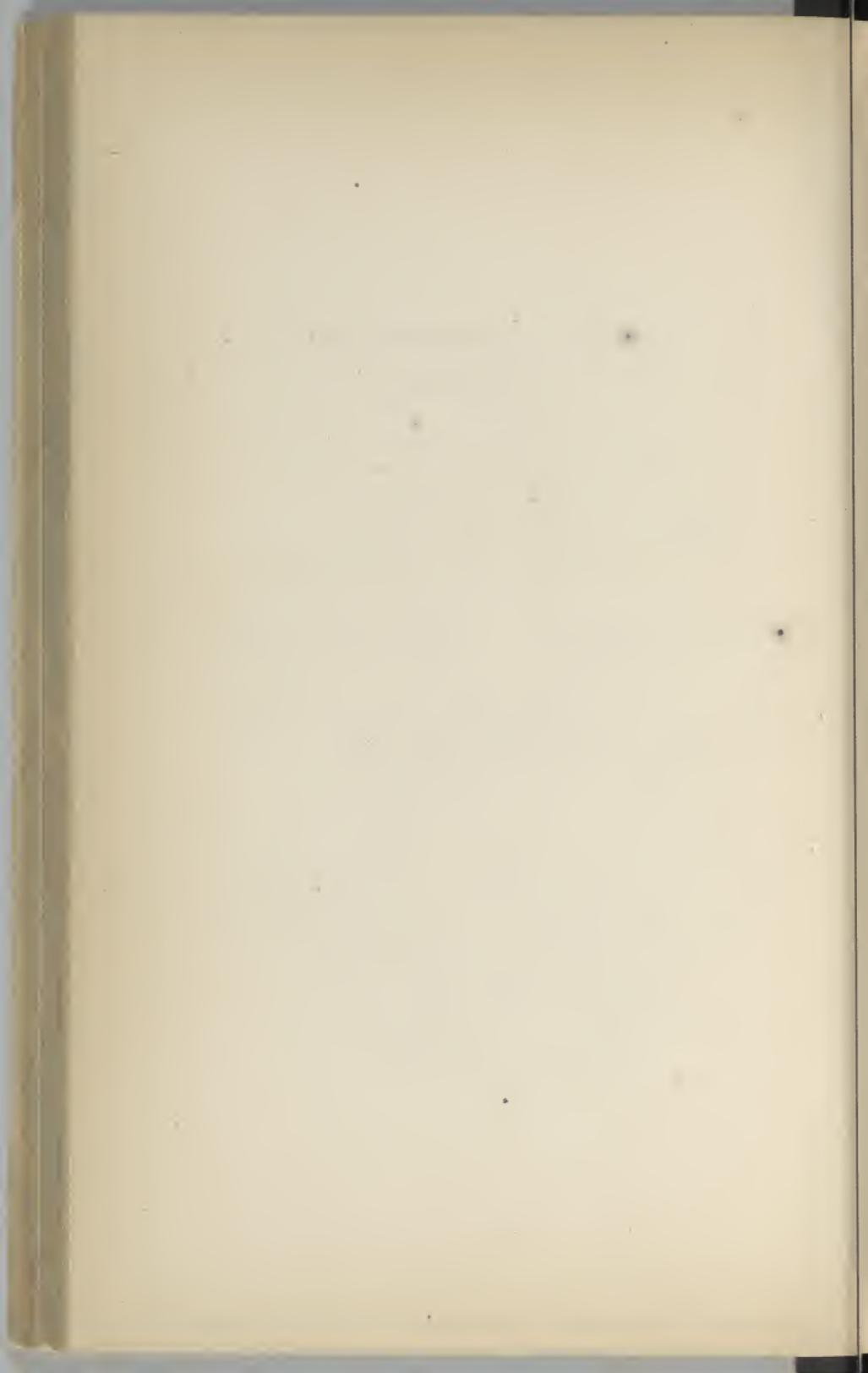
LEPAUTE'S ESCAPEMENT LAMP.

34. Order.

Fig. 6.

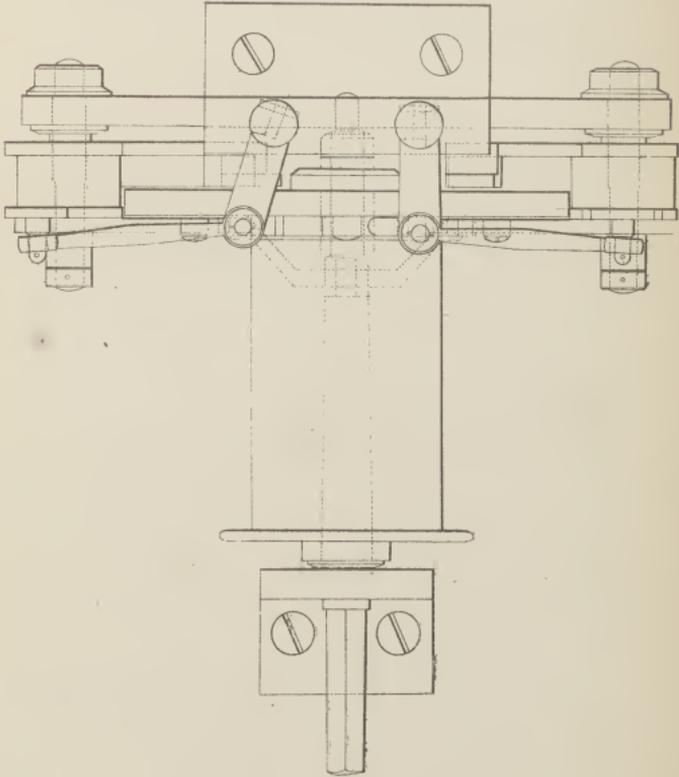
Elevation.





Plan

Fig. 7.



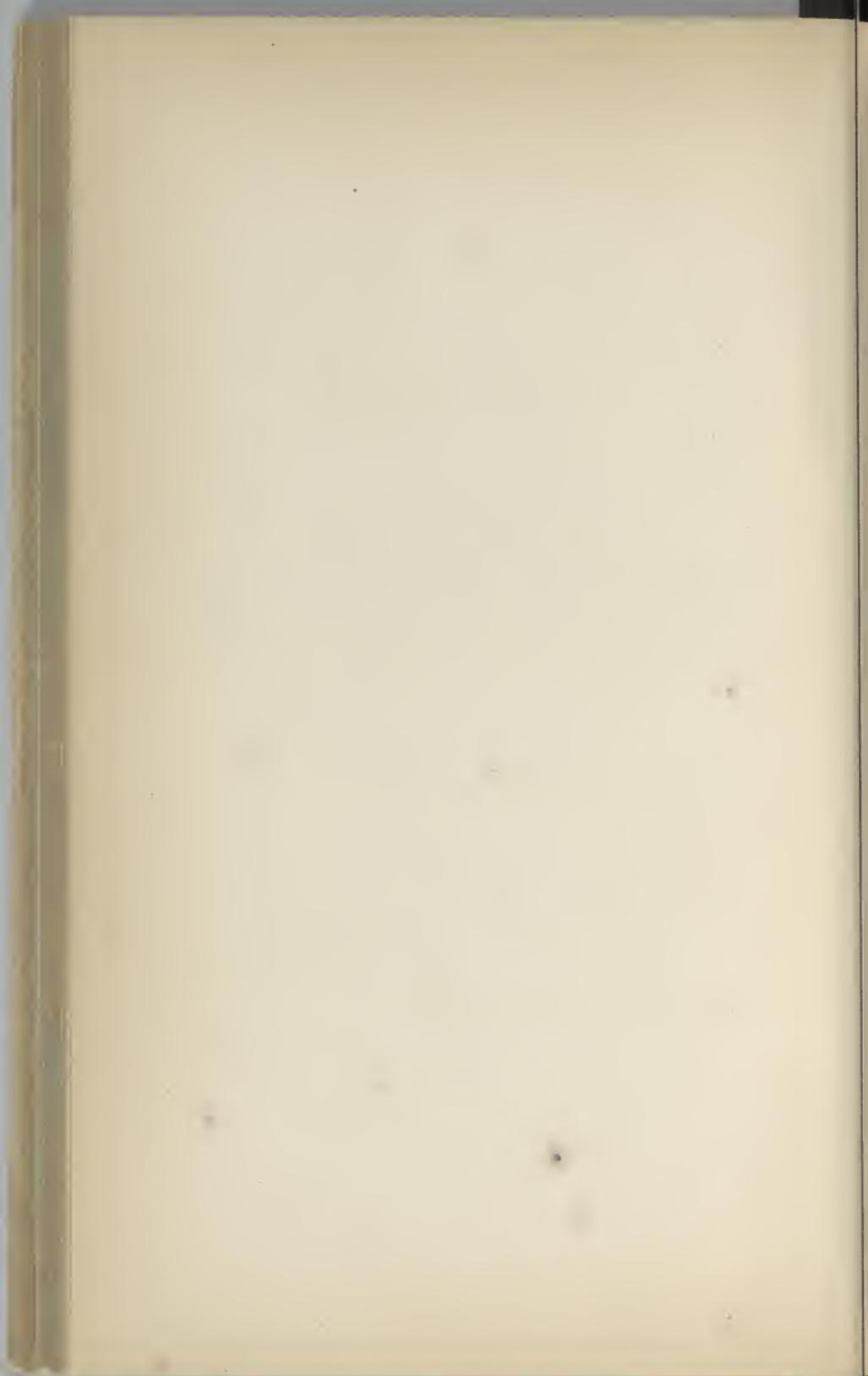




Fig. 8.

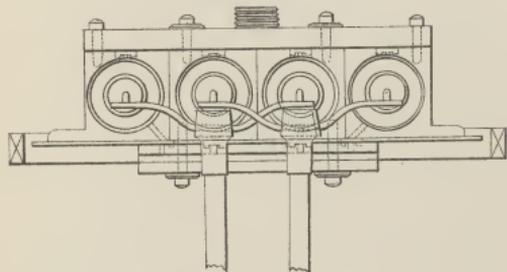


Fig. 9.



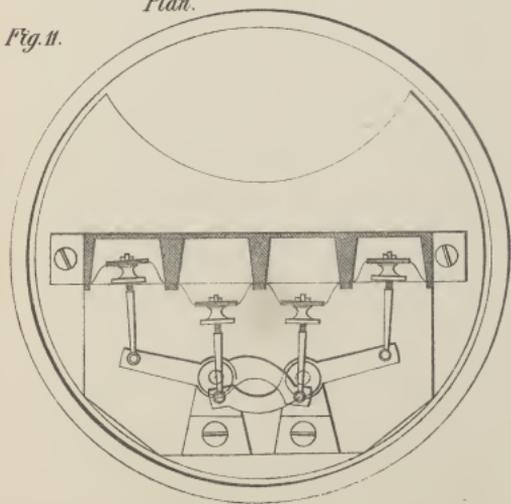
Fig. 10.

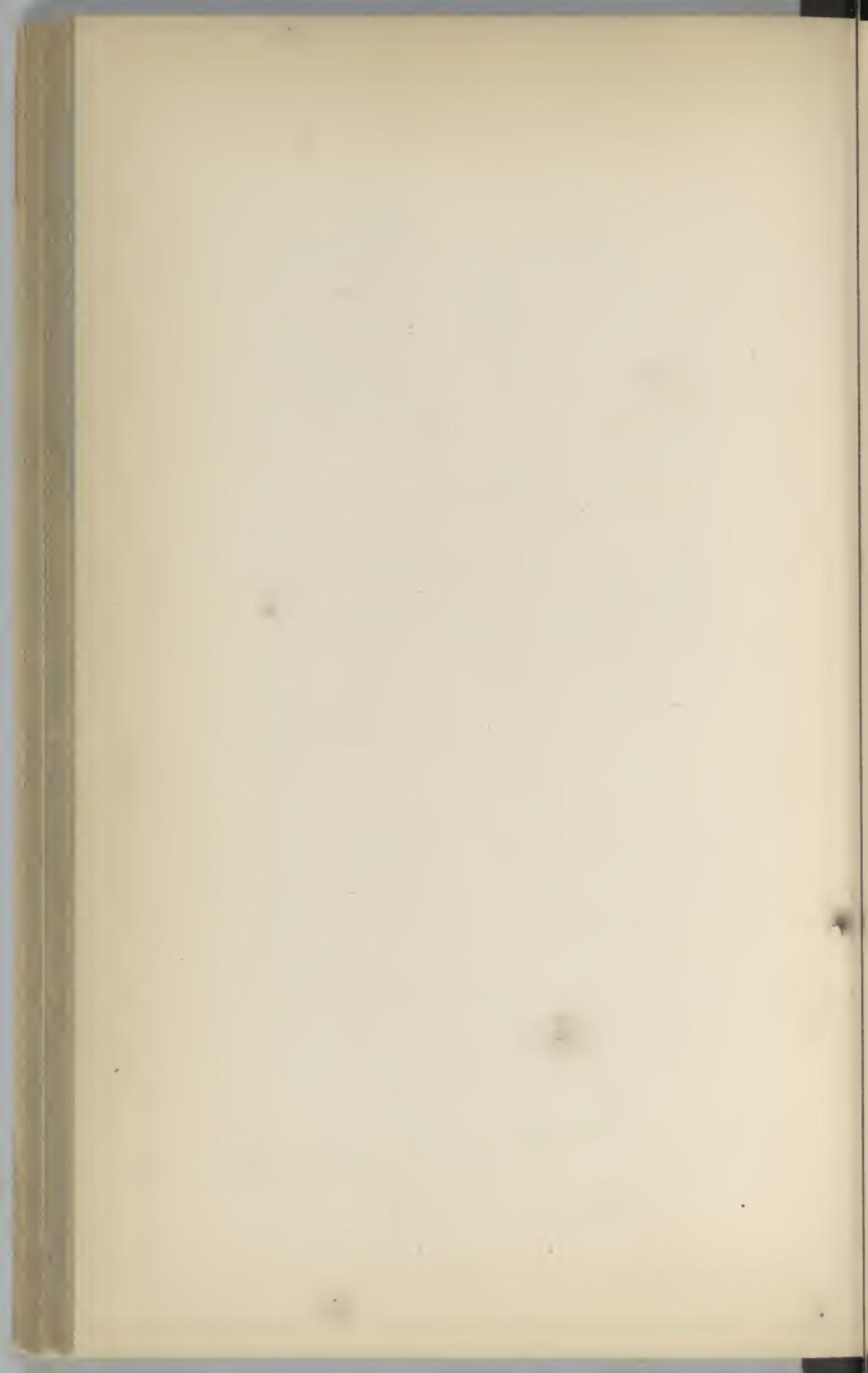
Elevation of Pump.



Plan.

Fig. 11.



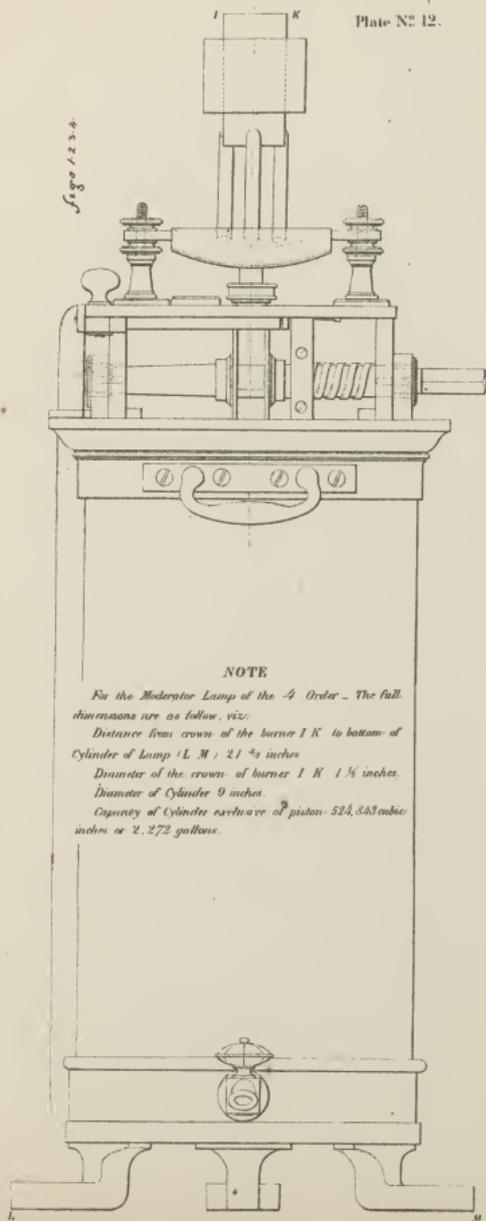


LEPAUTE'S MODERATOR LAMP.

3^d Order.

Fig. 1.

Plate N^o 12.



NOTE

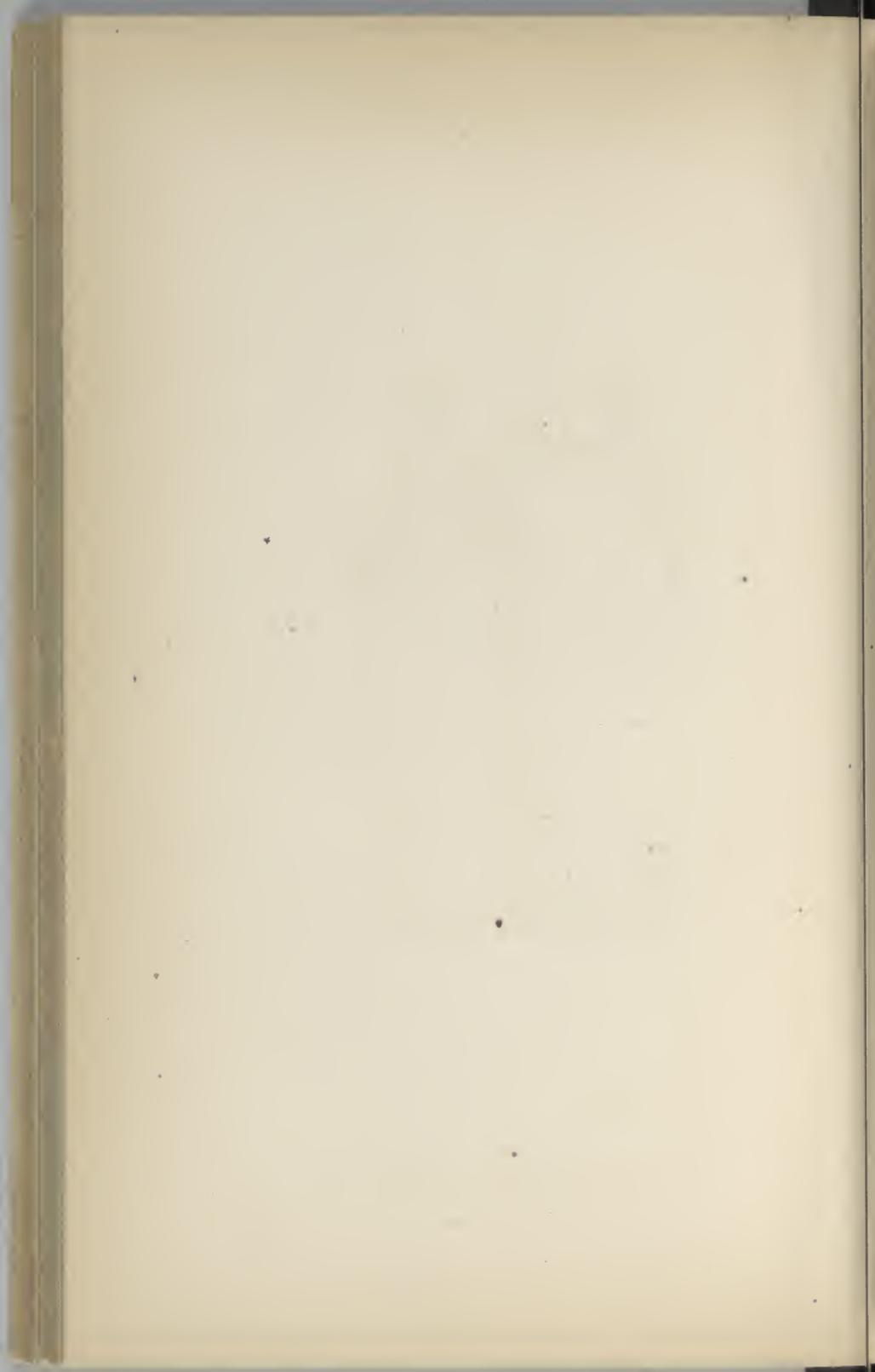
For the Moderator Lamp of the 4th Order - The full dimensions are as follow, viz:

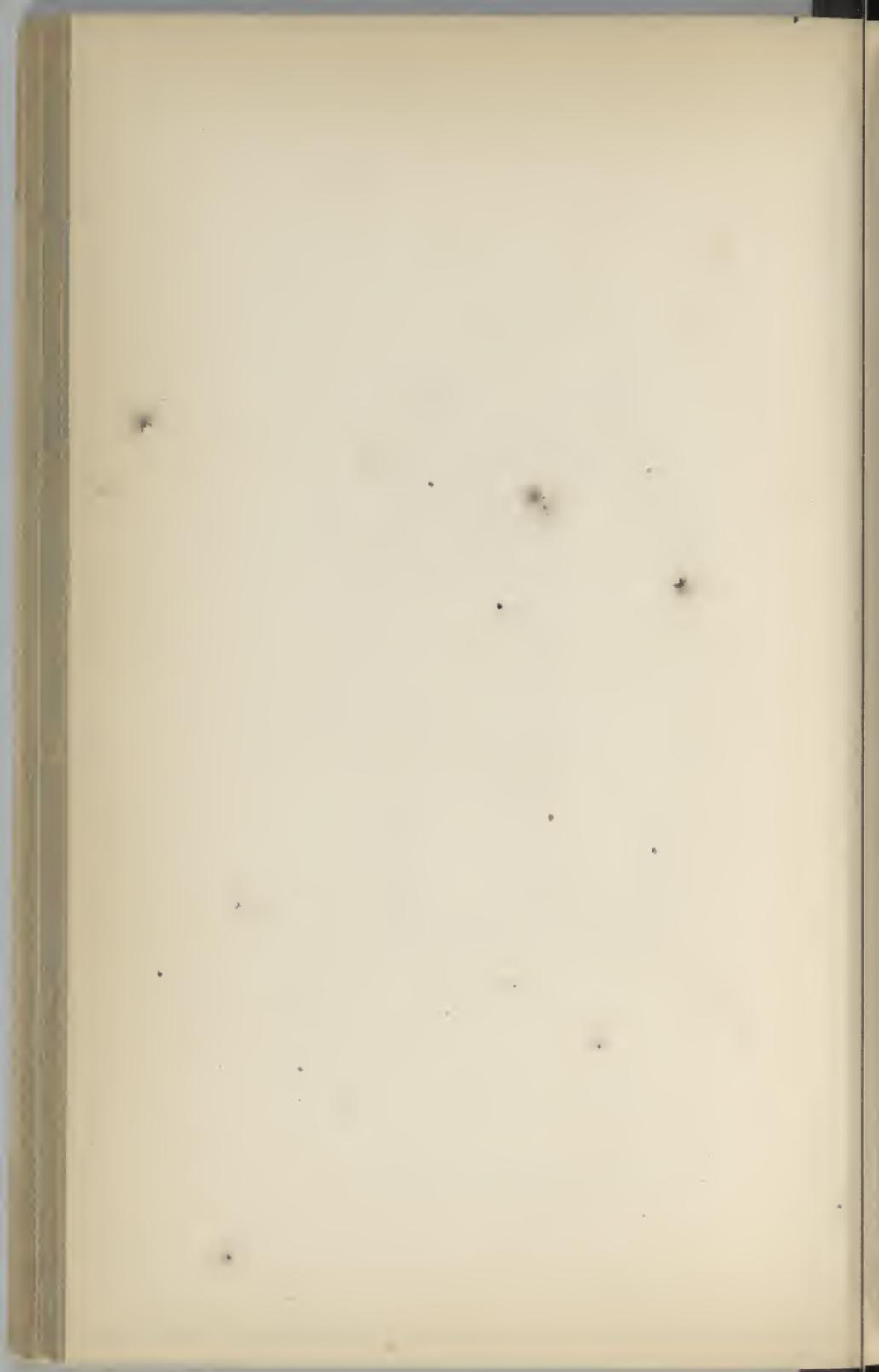
Distance from crown of the burner I K to bottom of Cylinder of Lamp (L M) 21 ³/₄ inches

Diameter of the crown of burner I K 1 ¹/₂ inches

Diameter of Cylinder 9 inches.

Capacity of Cylinder exclusive of piston 524,663 cubic inches or 2,272 gallons.





LEPAUTE'S MODERATOR LAMP.

3^d Order.

Fig. 3.

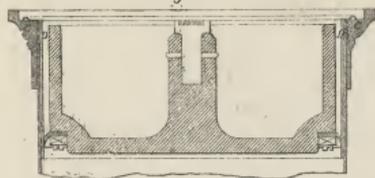
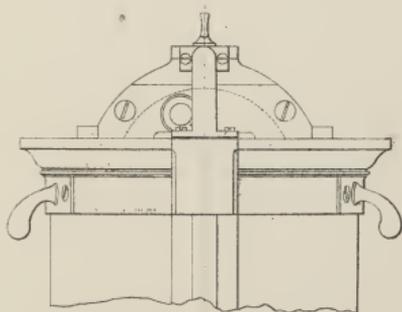
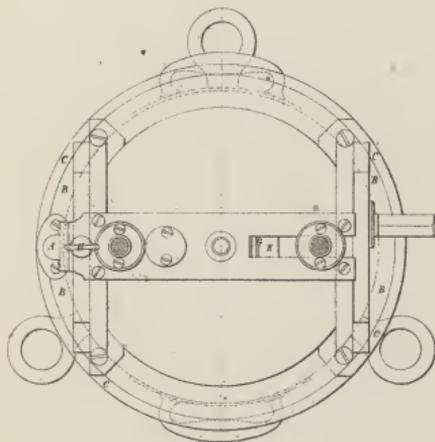
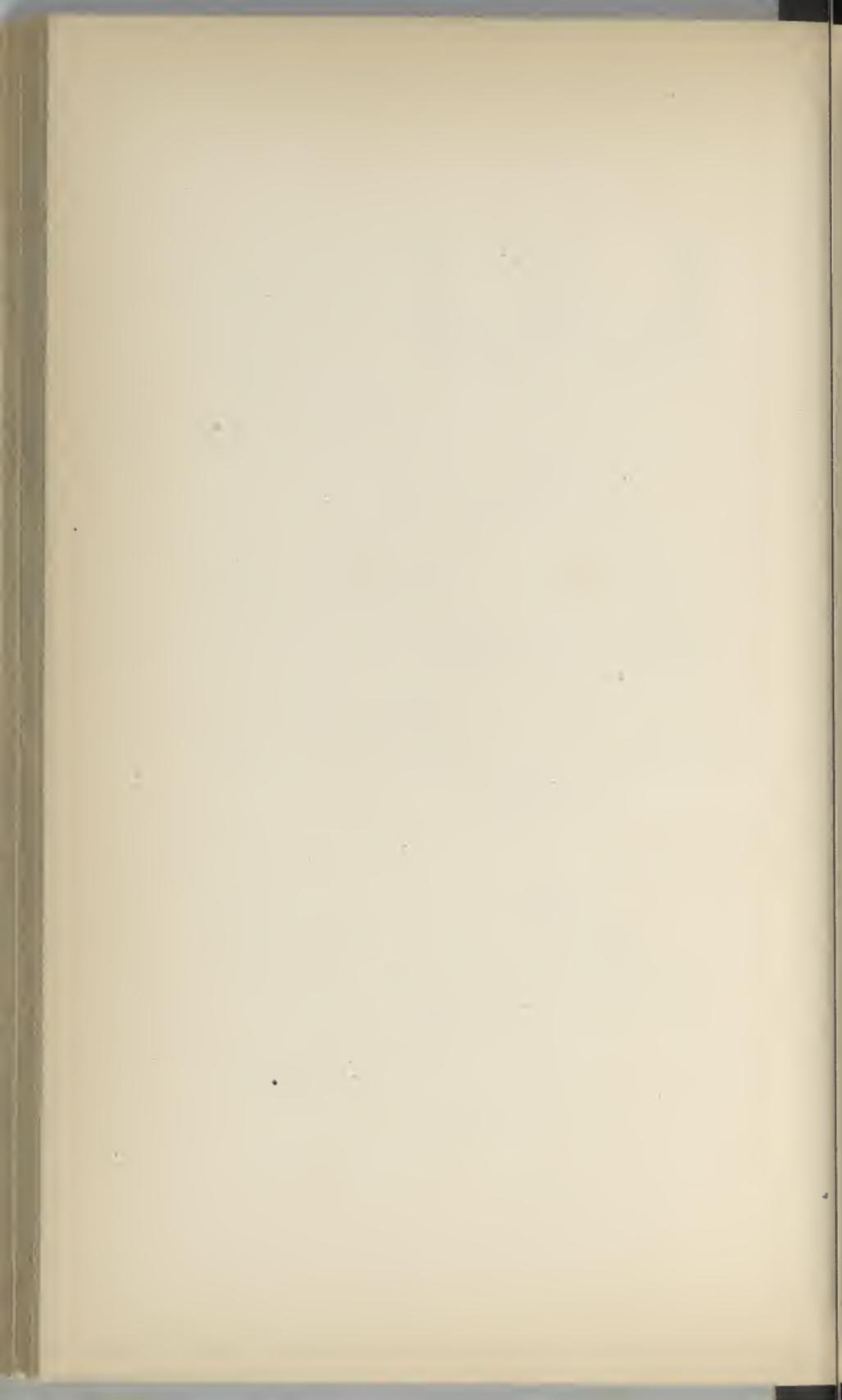


Fig. 4.





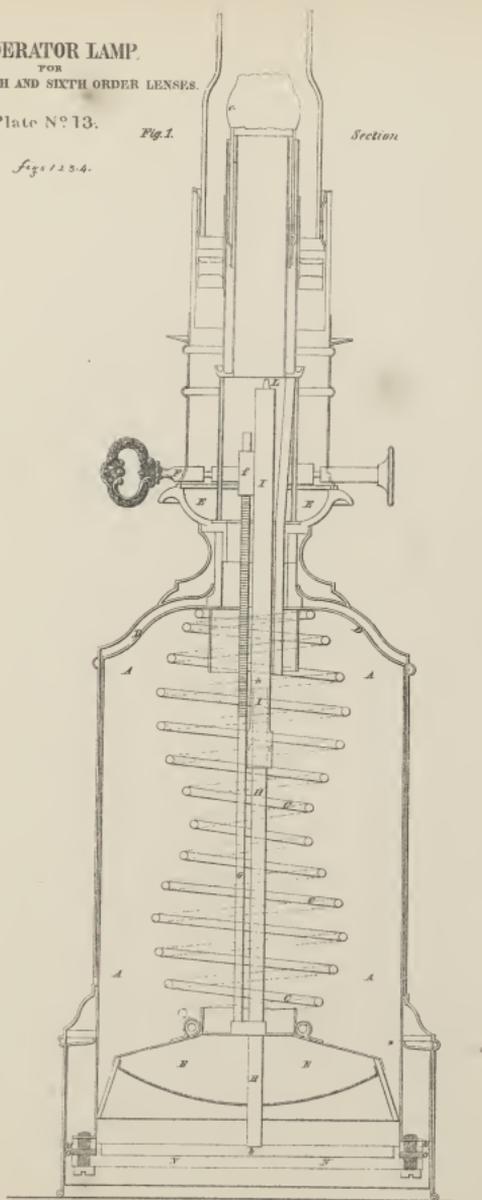
MODERATOR LAMP.
FOR
FOURTH, FIFTH AND SIXTH ORDER LENSES.

Plate N^o 13.

Fig. 1.

Section

Figs 1 2 3 4.



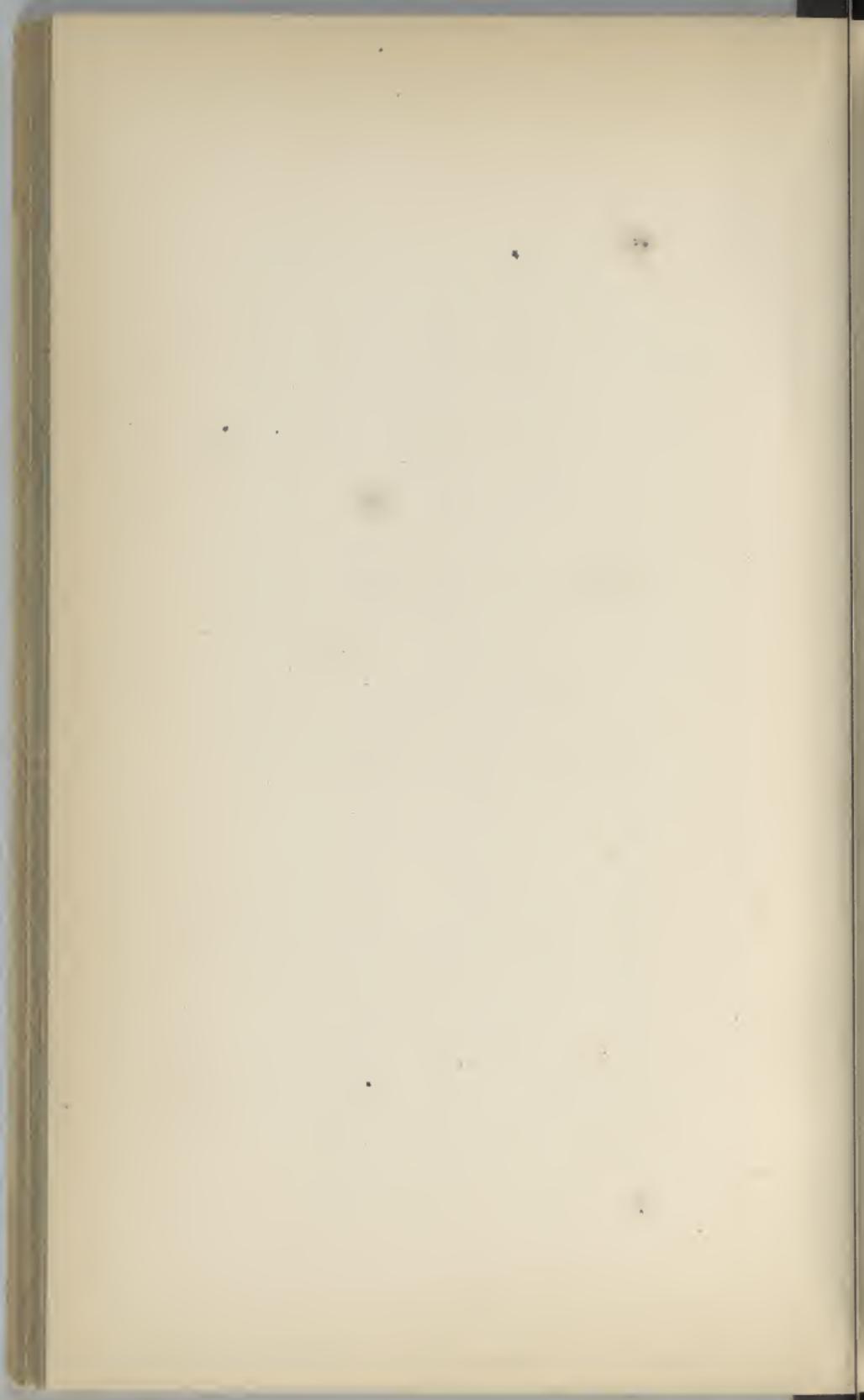
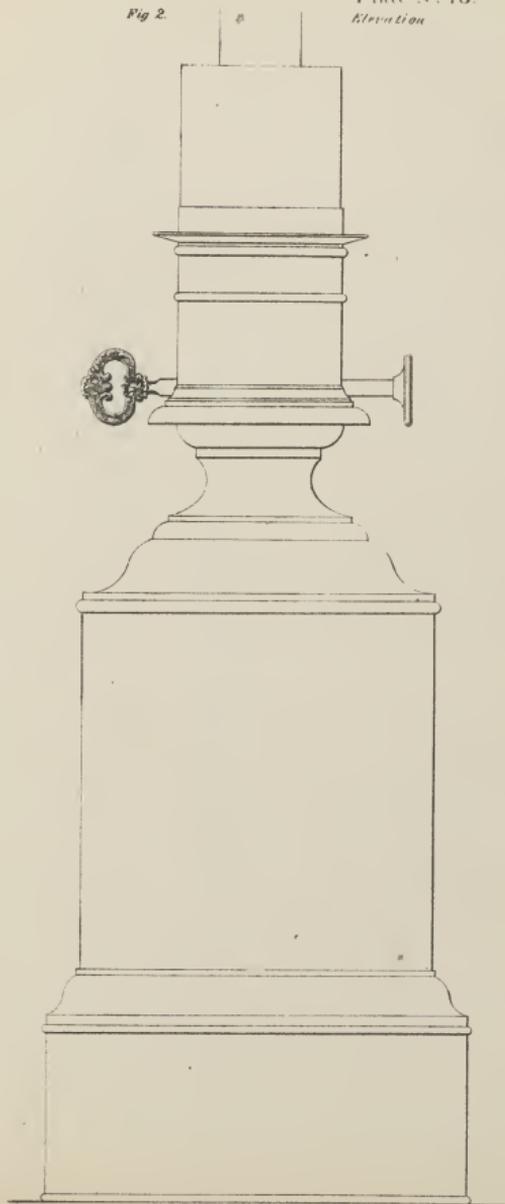
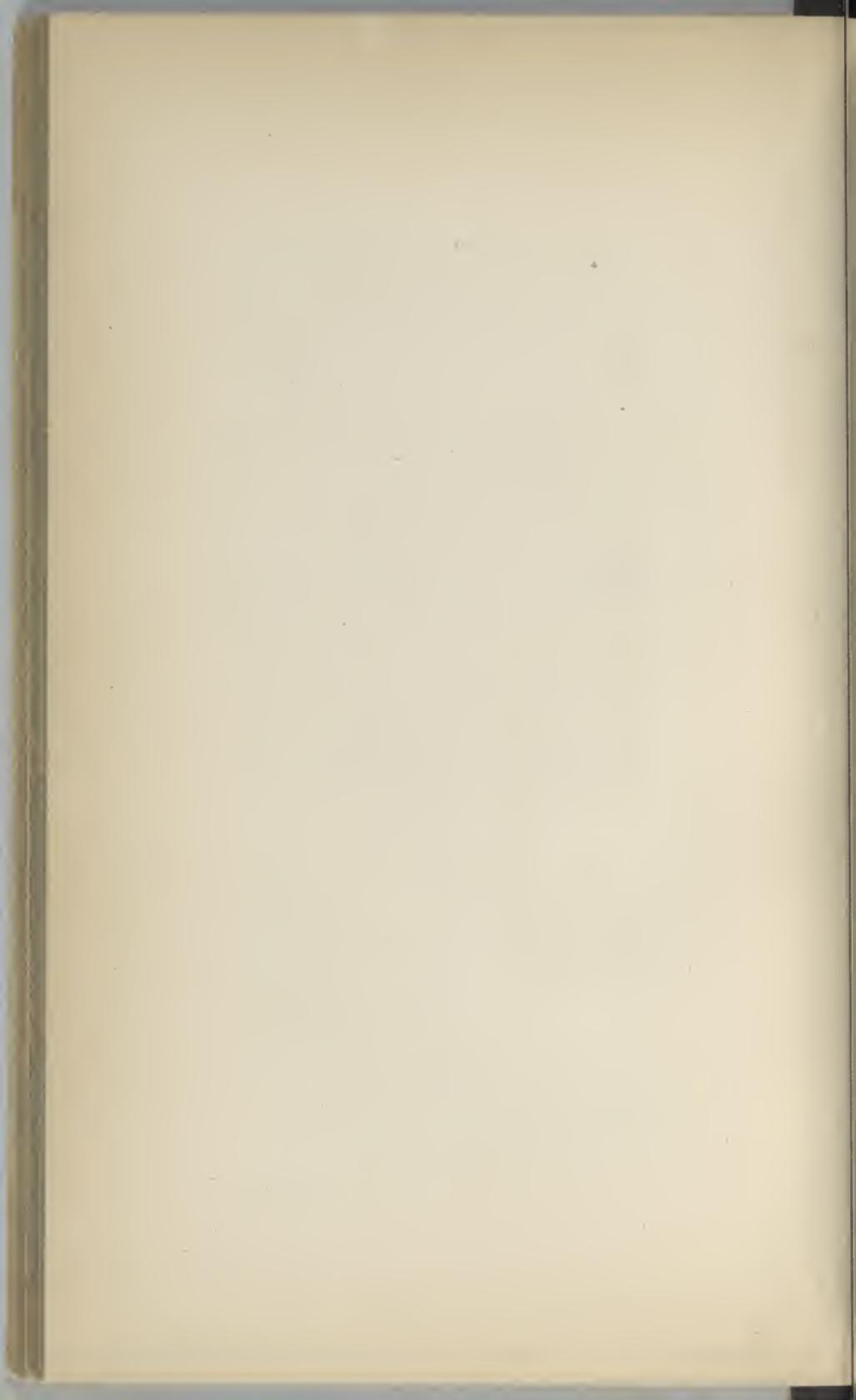
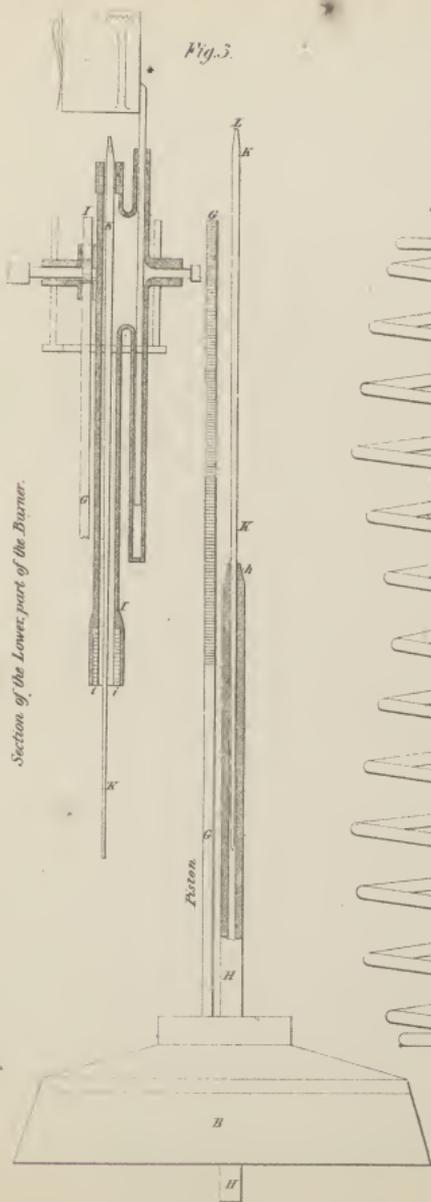


Fig 2.

Elevation







Section of the Lower part of the Burner.

Fig. 3.

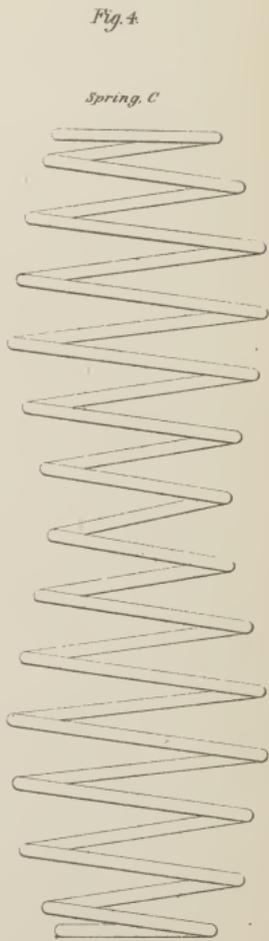
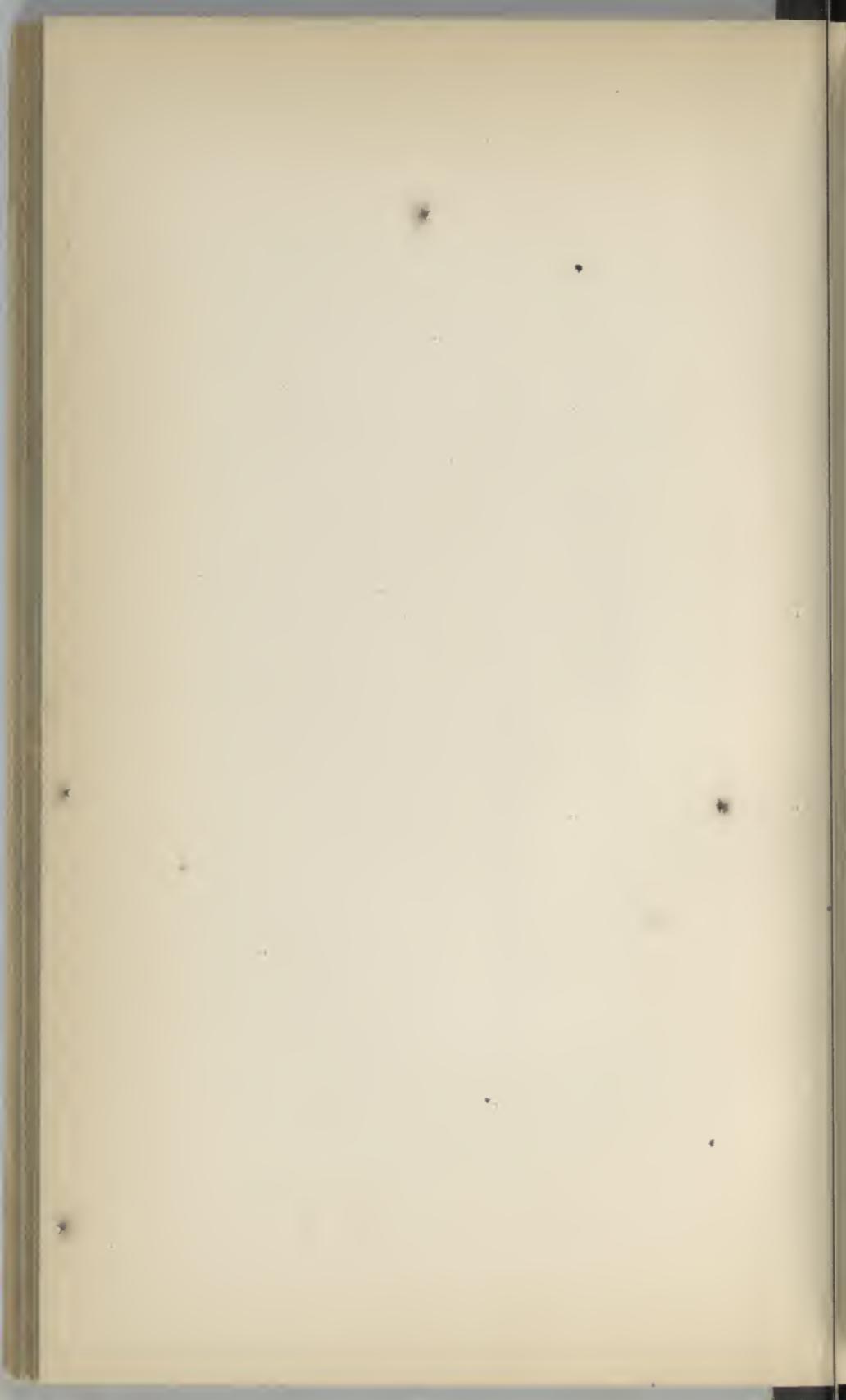


Fig. 4.

Spring, C.

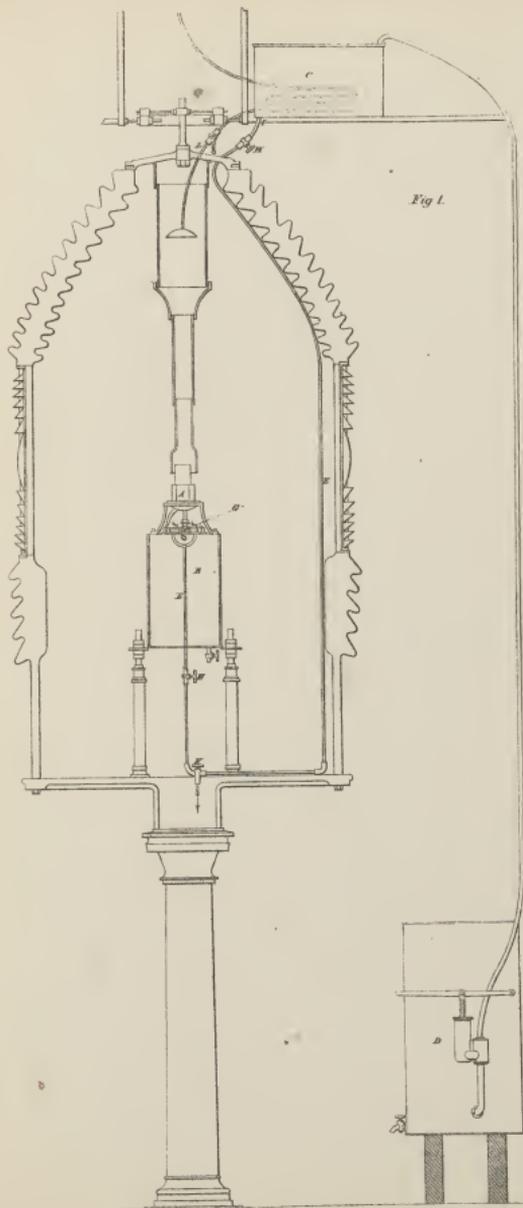
NO. 11111



HYDRAULIC LAMP

as adapted to lenses of the 1st, 2^d, & 3^d order

Plate N^o 16.



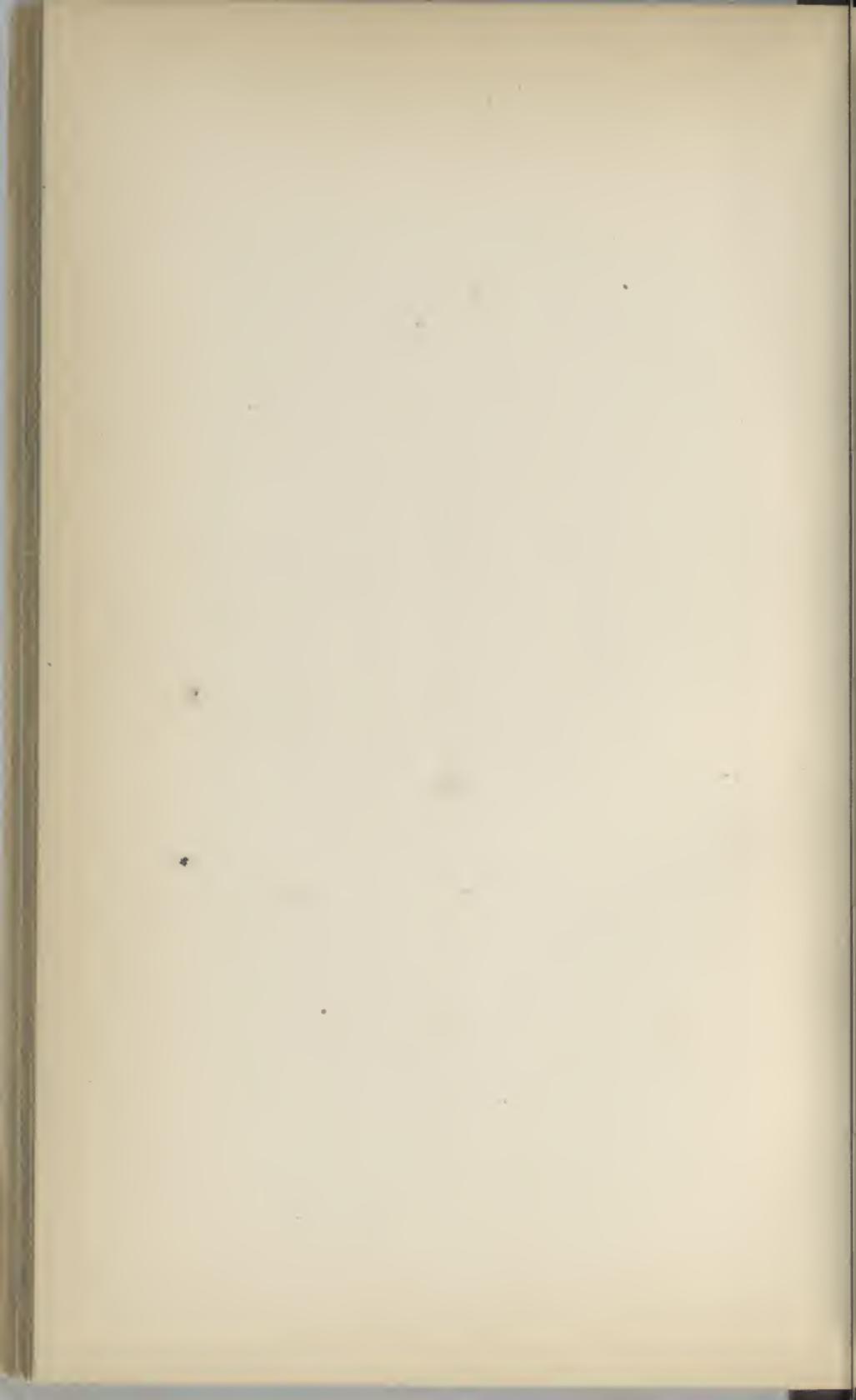
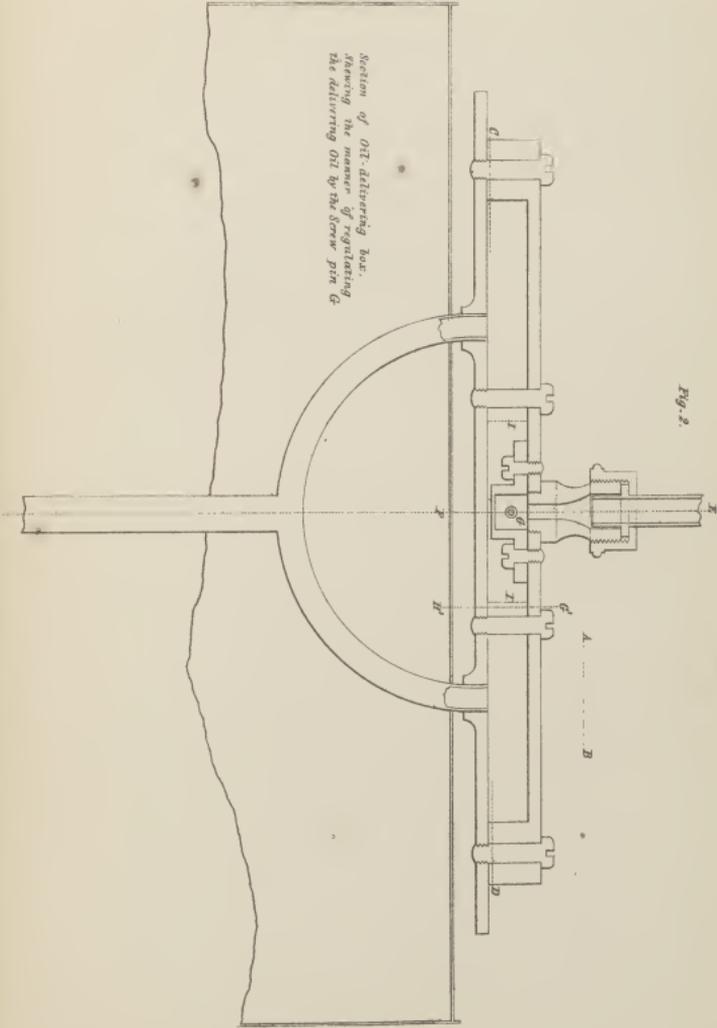
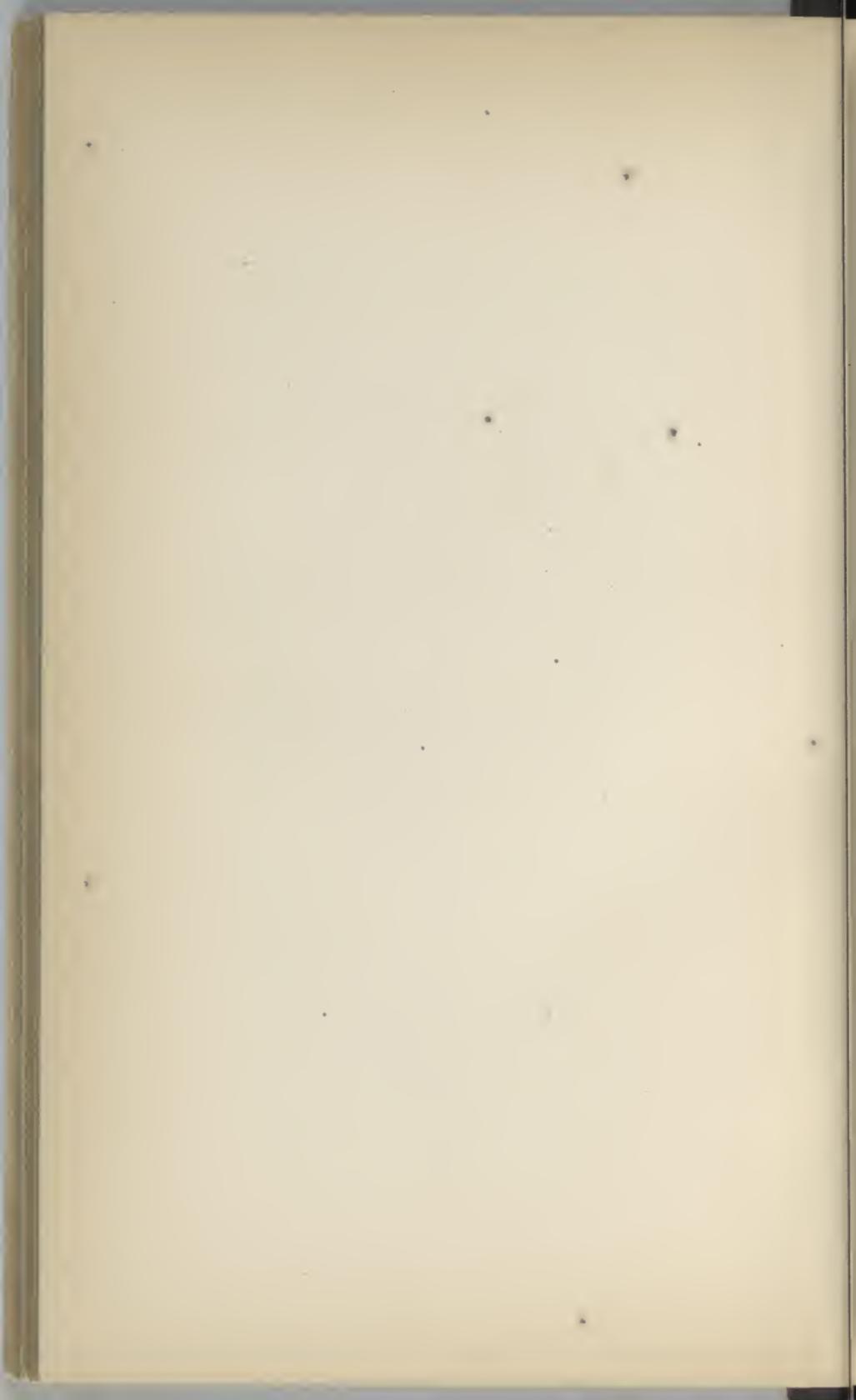
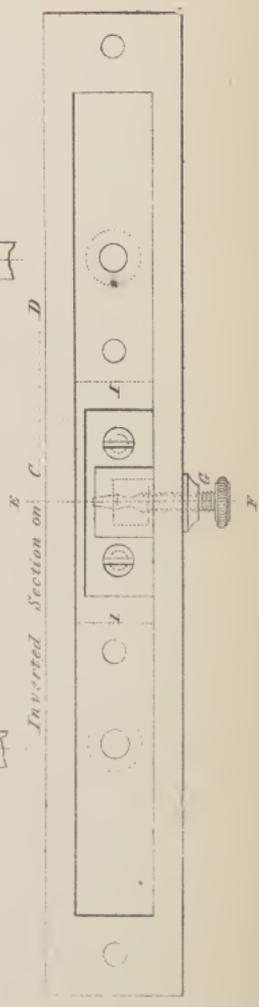
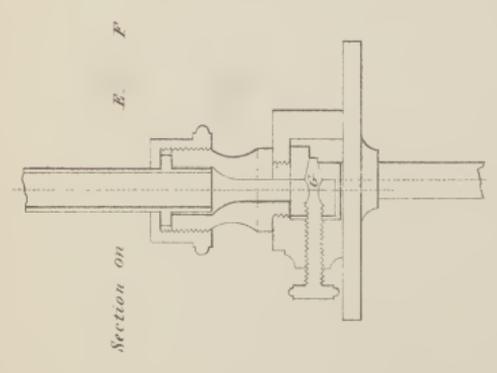
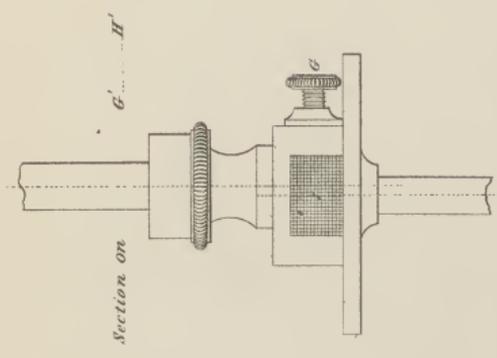


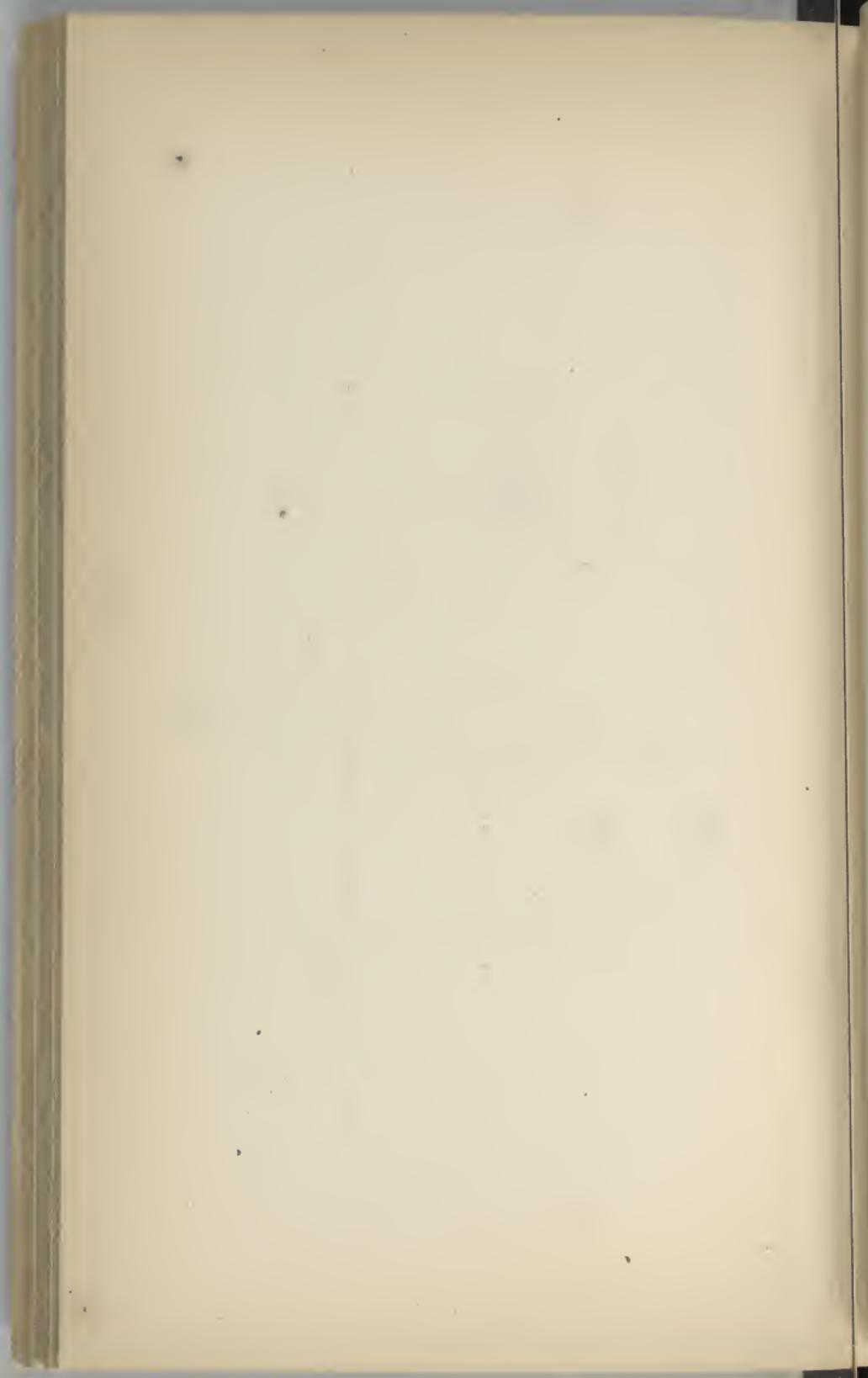
Fig. 2.

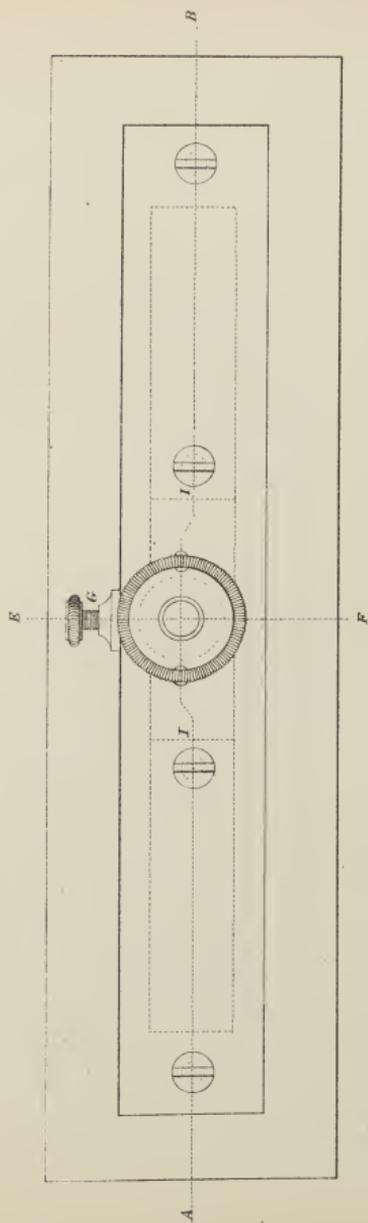


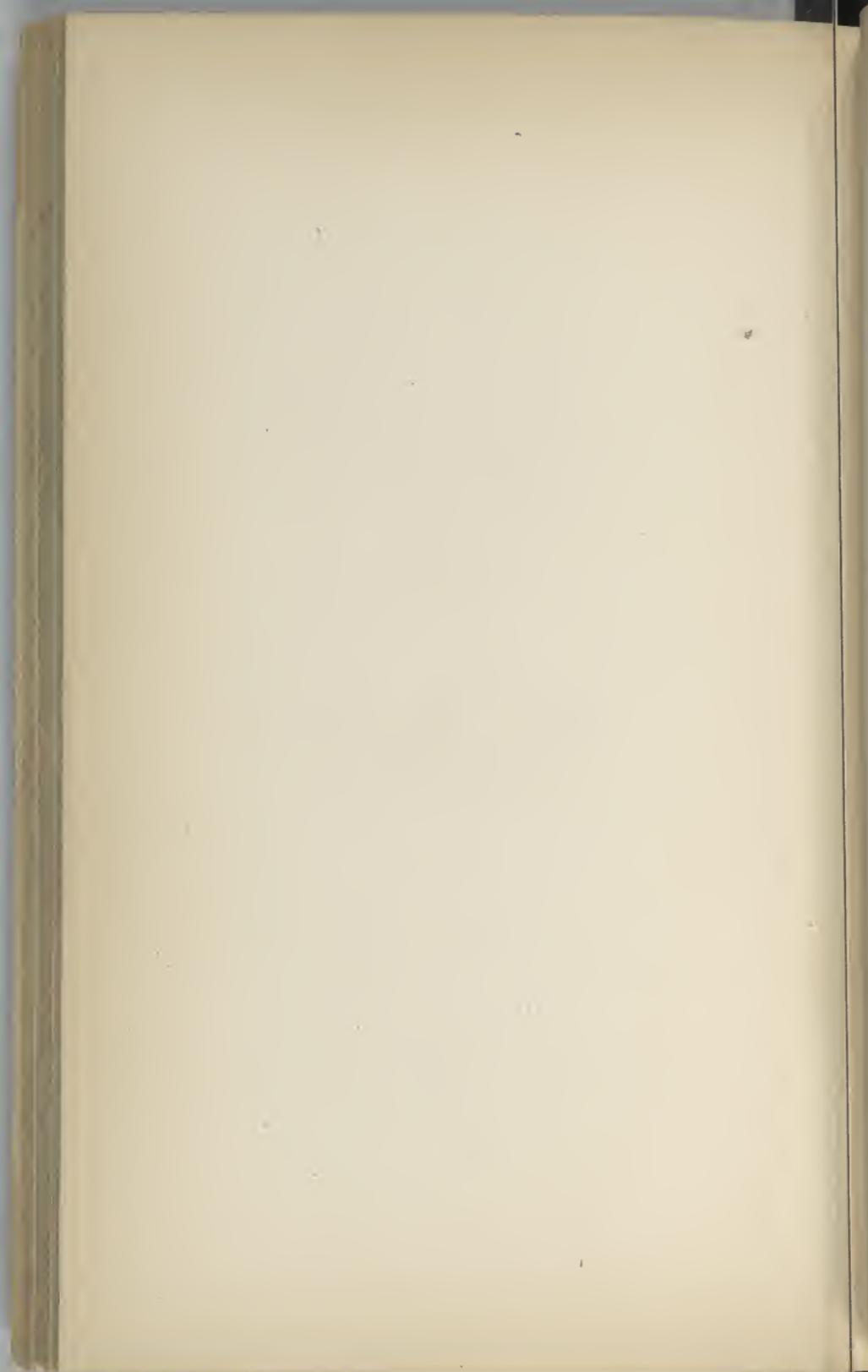
Section of Oil-delivering bar,
showing the manner of regulating
the delivering Oil by the screw pin G.







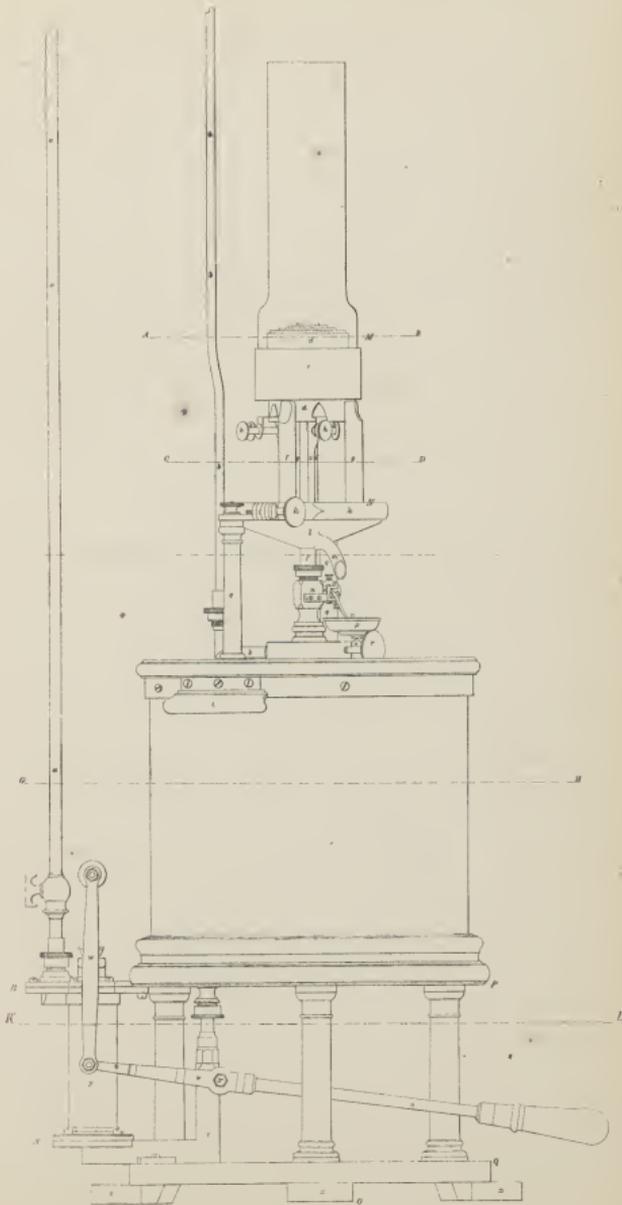


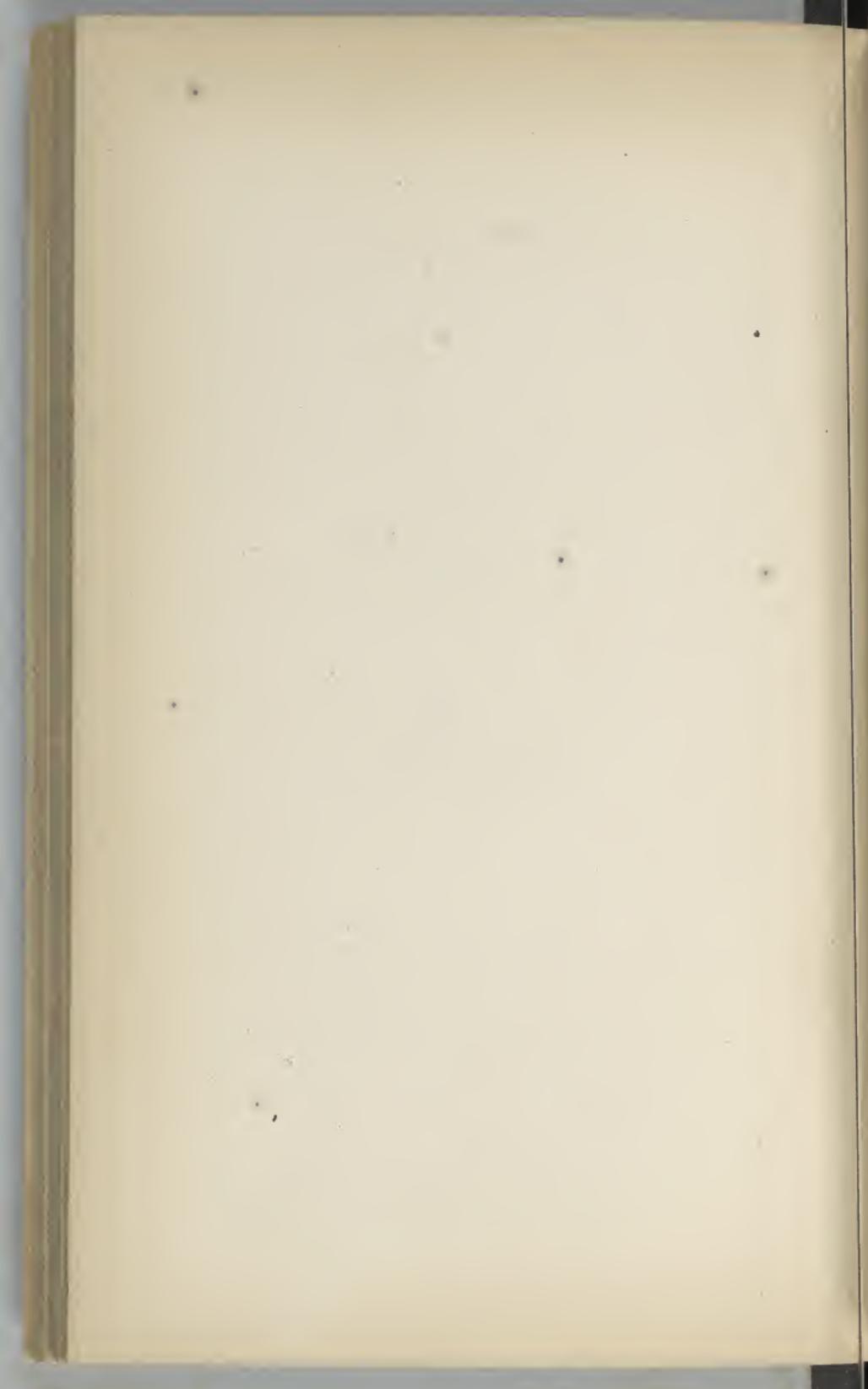


FIRST ORDER HYDRAULIC LAMP.

Elevation on the plane of the axes of pump and lamp.

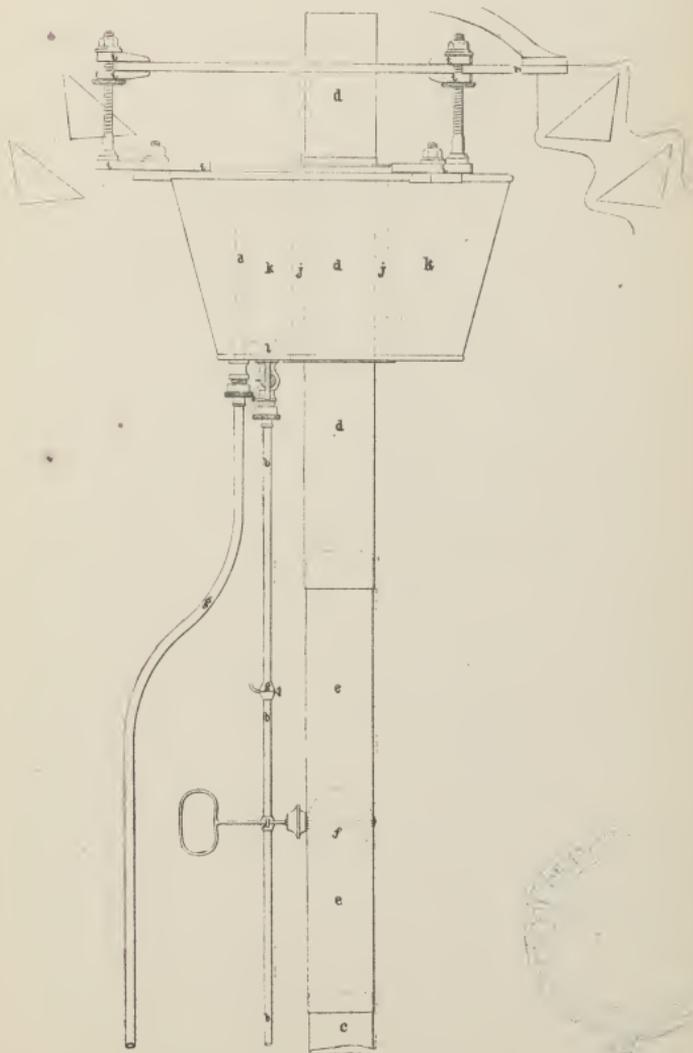
Plate No 1

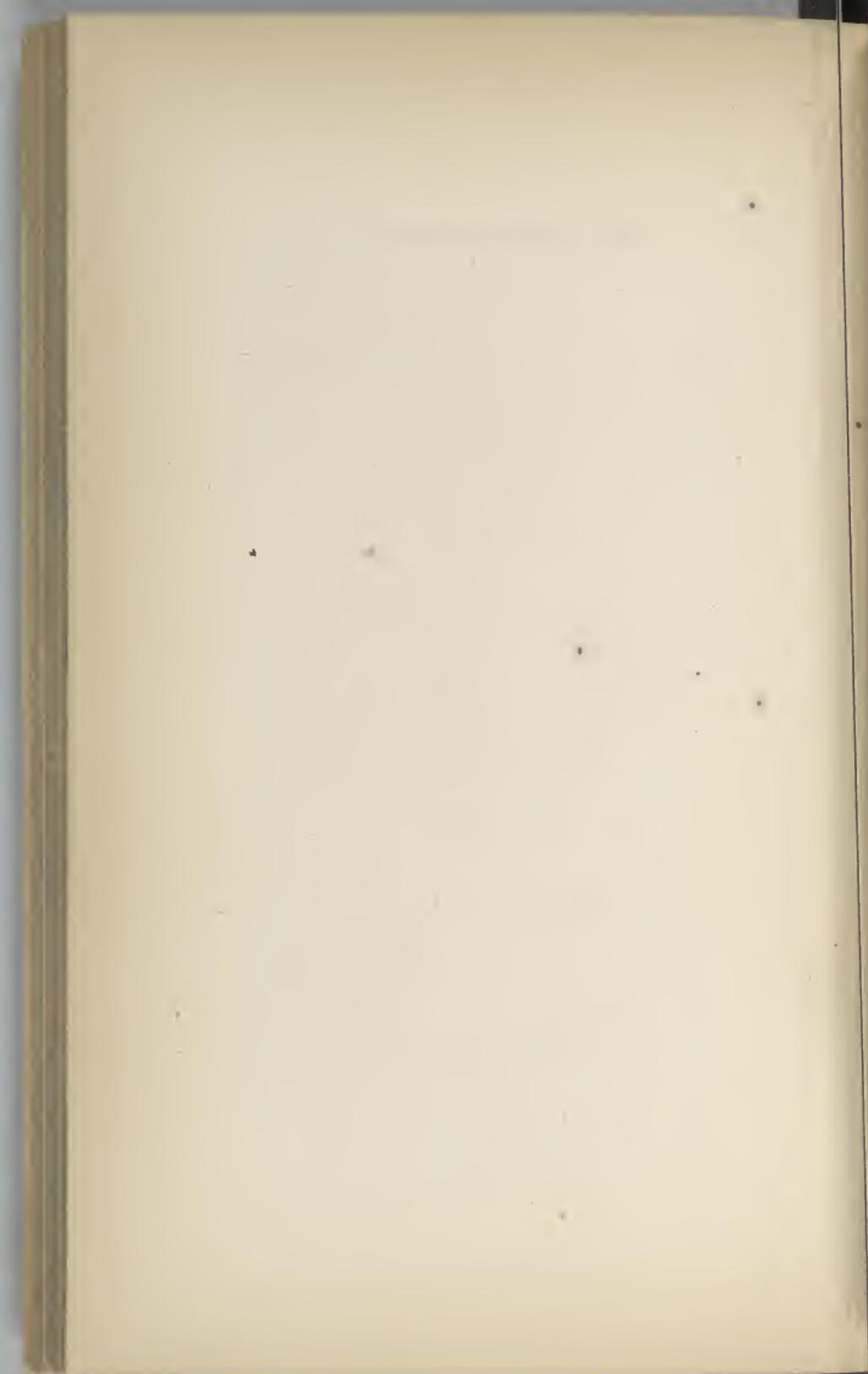




FIRST ORDER HYDRAULIC LAMP.

Élevation en la Plaque 36 II



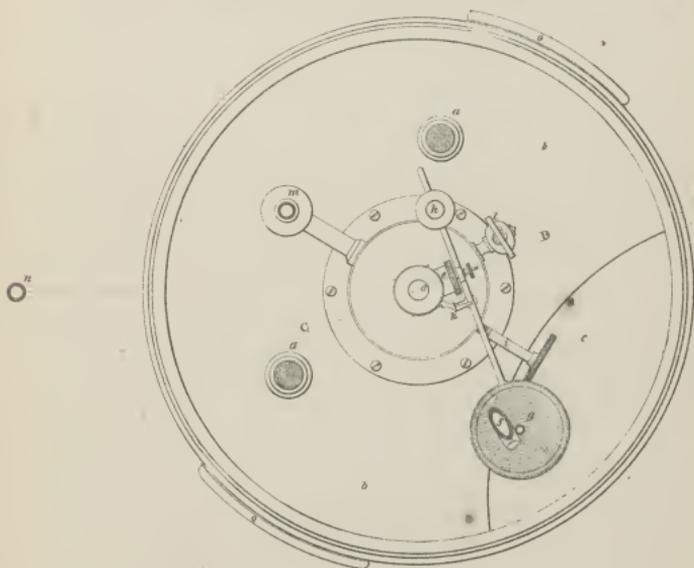


FIRST ORDER HYDRAULIC LAMP.

Sectional Plan

Plate No. III.

Section on EP (Pl. I) Plan from EF to GH.



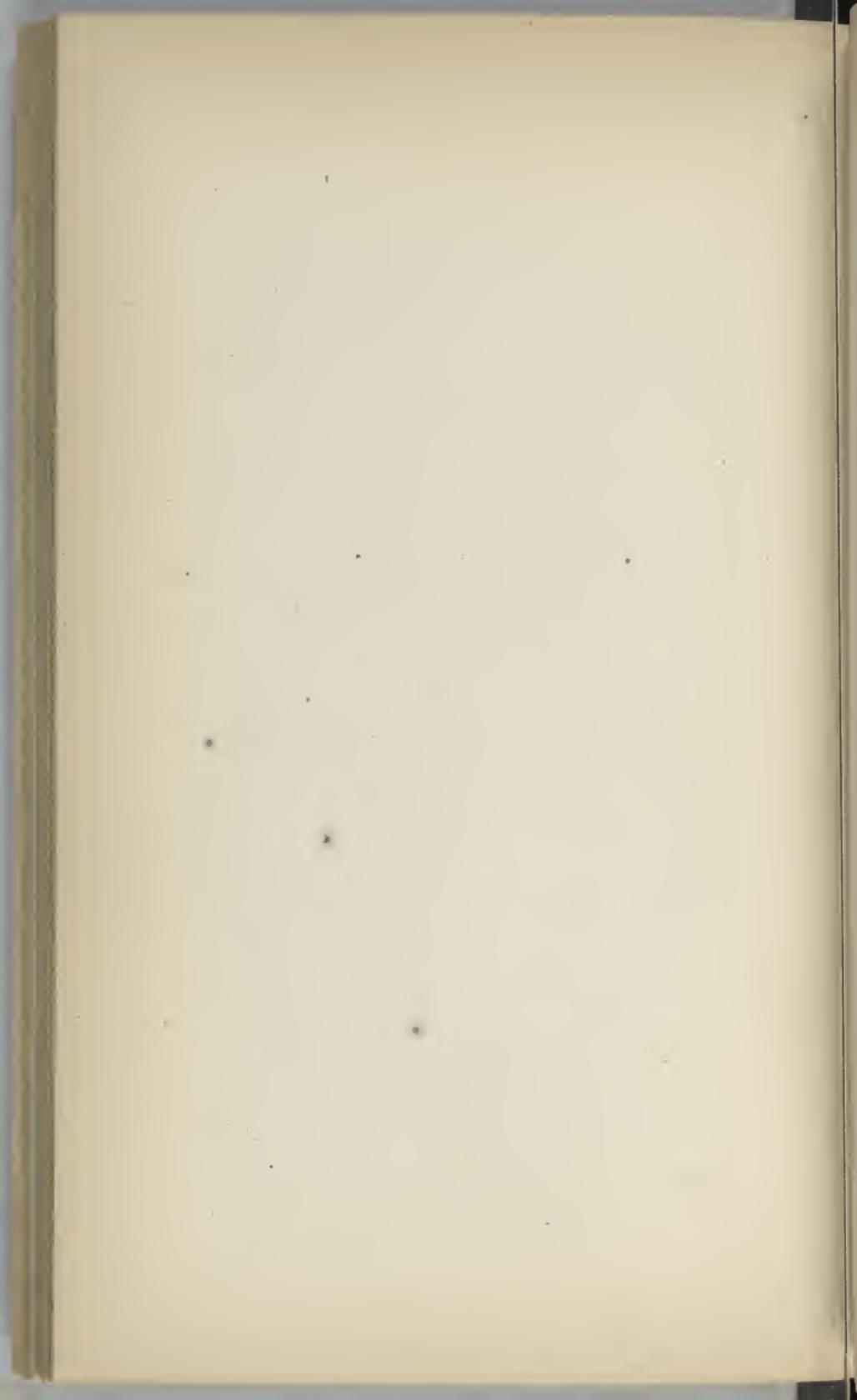
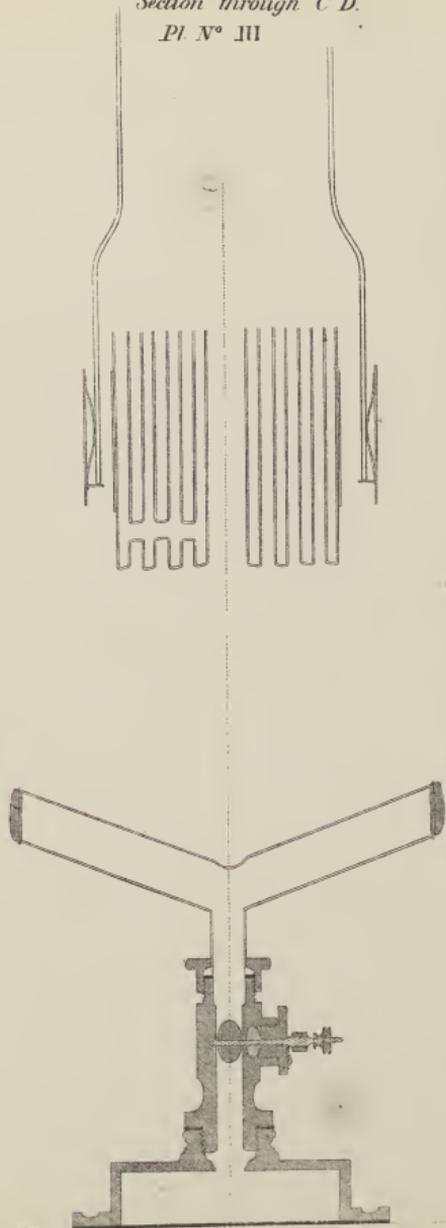


Fig. 2.

Section through C D.
Pl. N° III



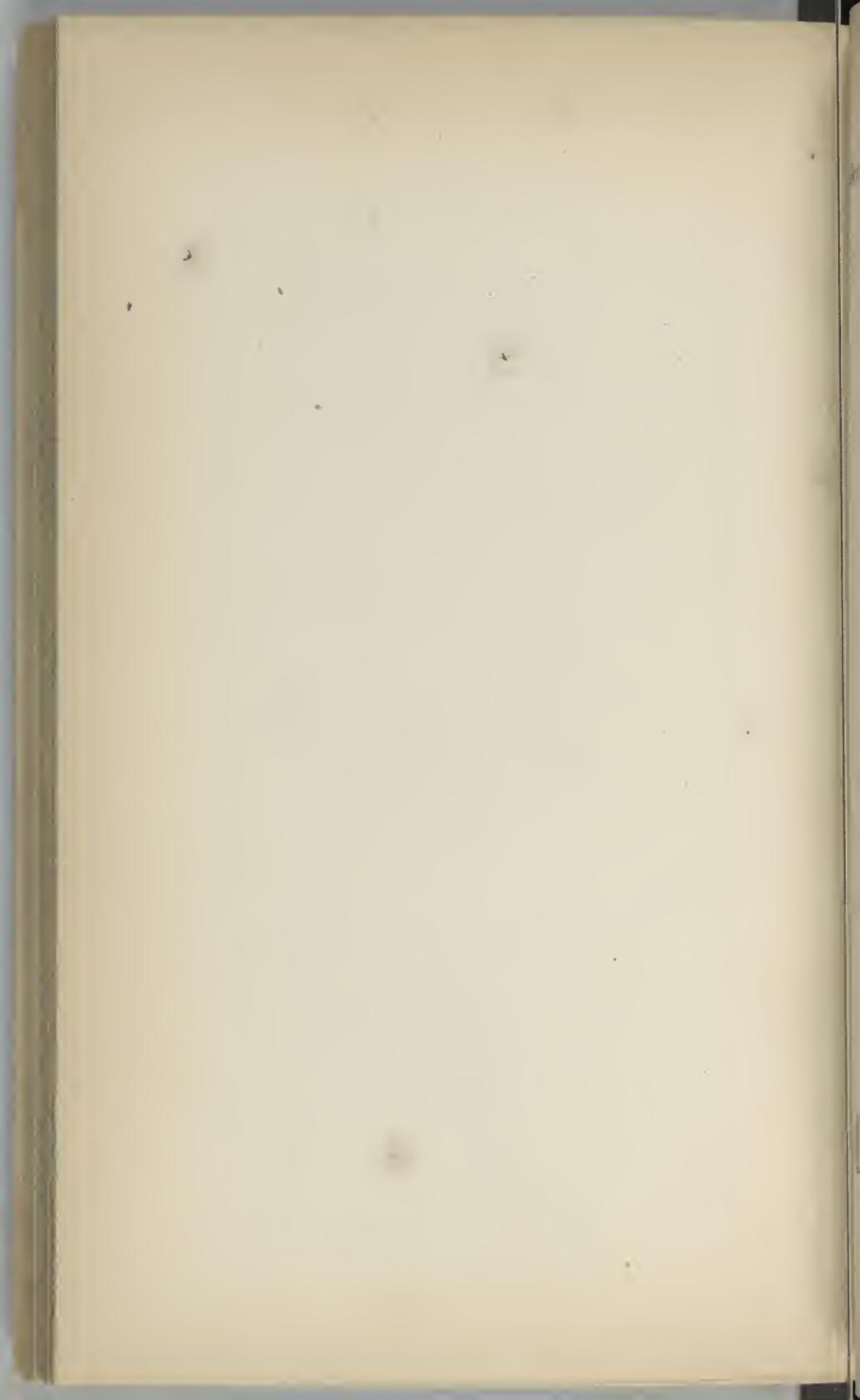
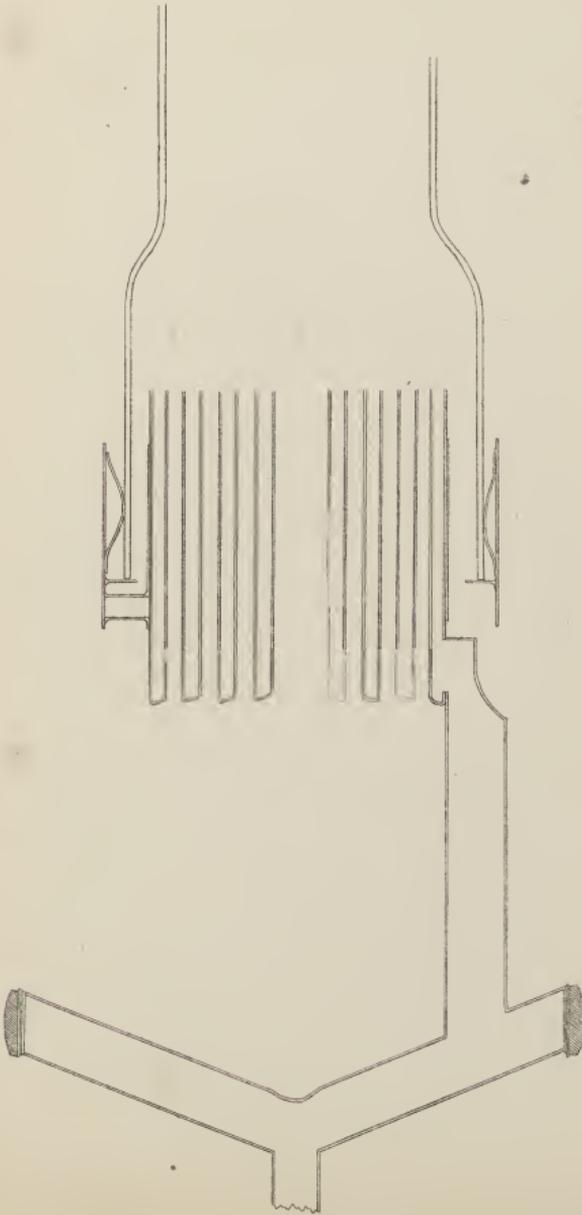
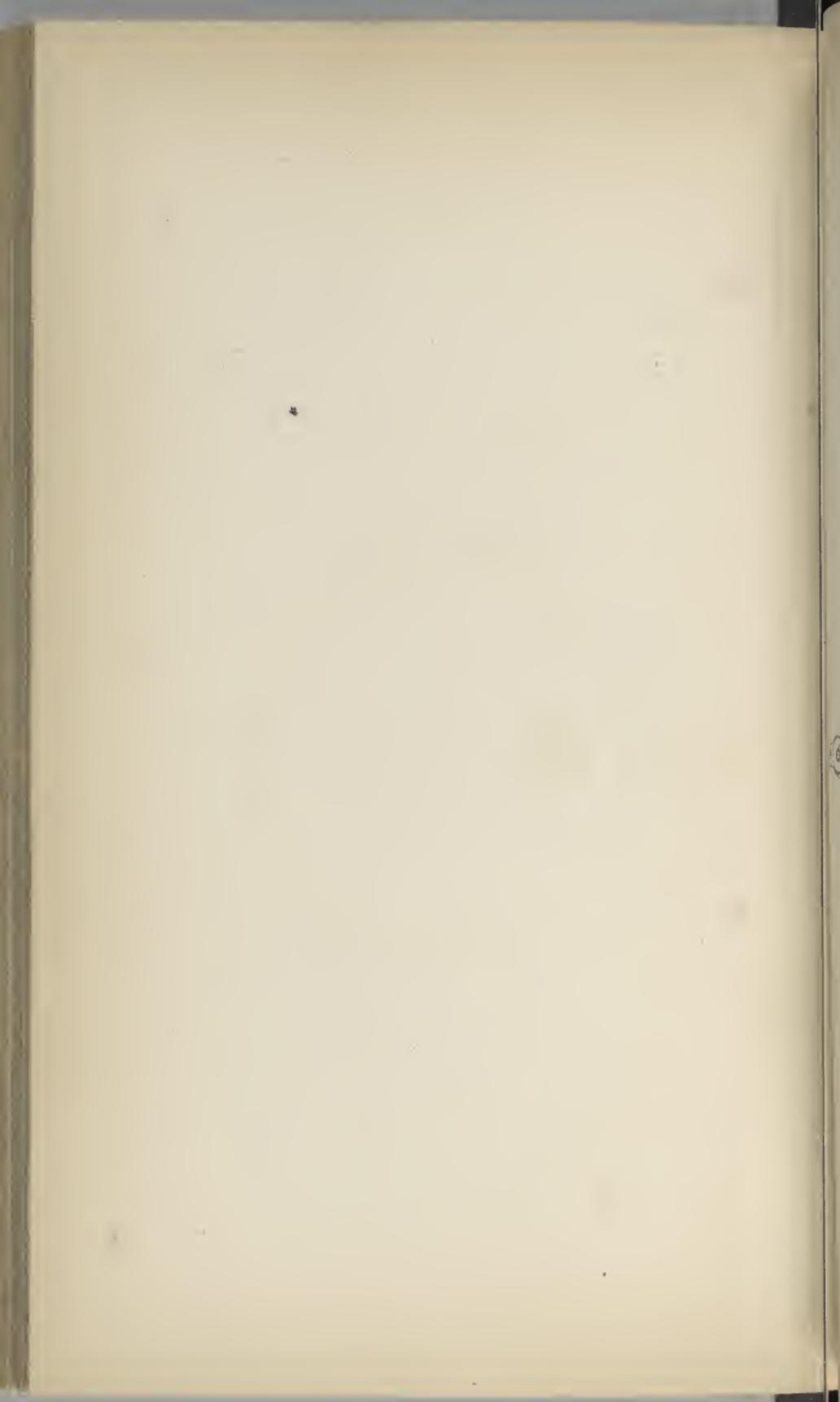


Fig. 3.

Section of burner through pipe f Pl. I.

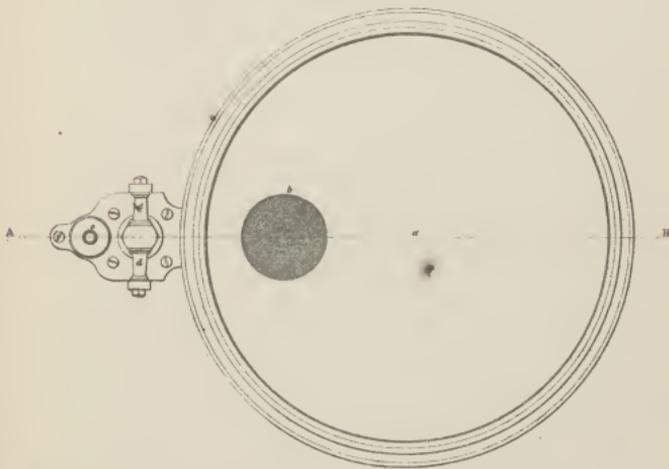


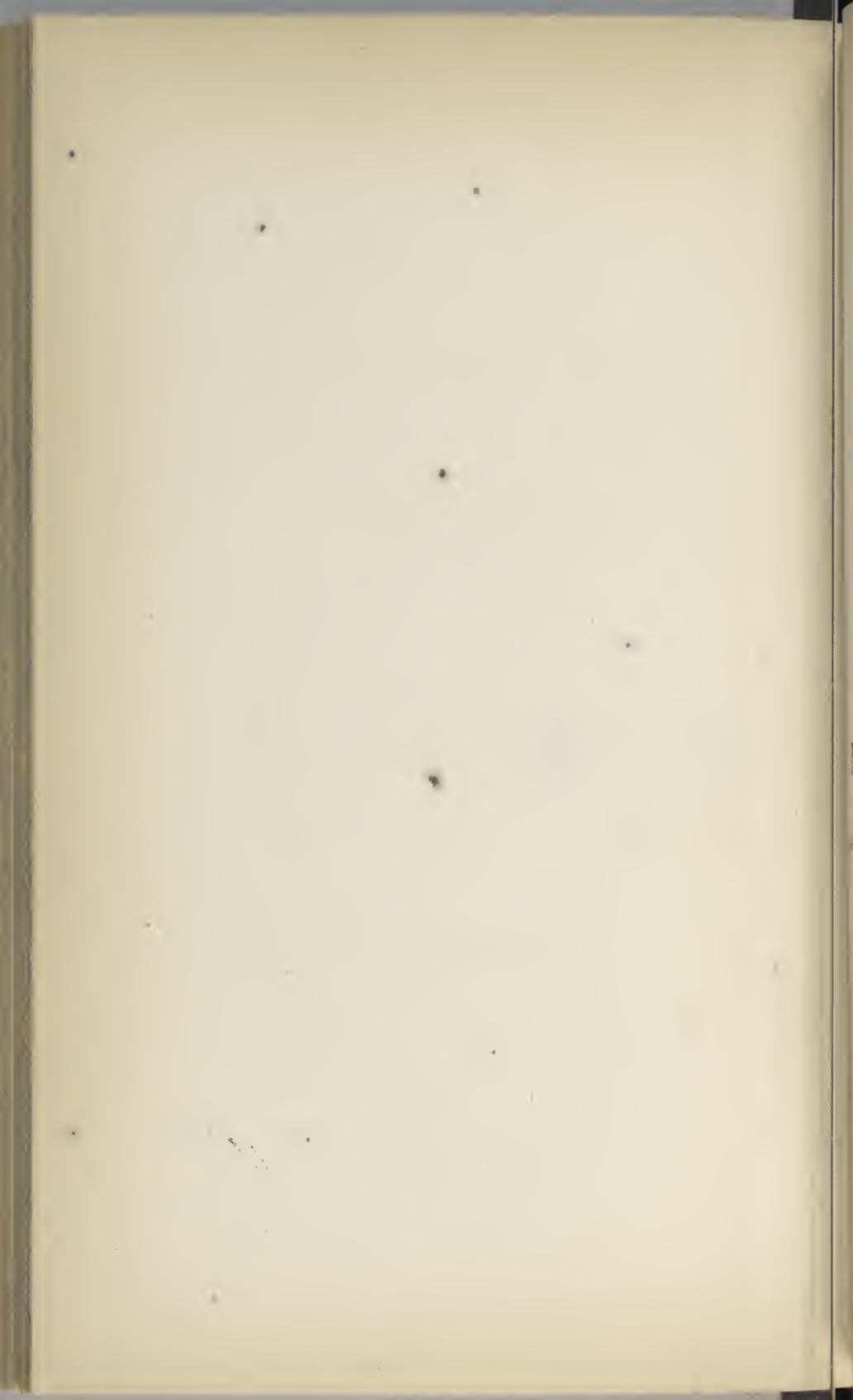


FIRST ORDER HYDRAULIC LAMP.

Plate No. B.

Section on GH (Pl. 1.) Plan from GH to KL.





FIRST ORDER HYDRAULIC LAMP.

Section through A B Top View of Fig. 1

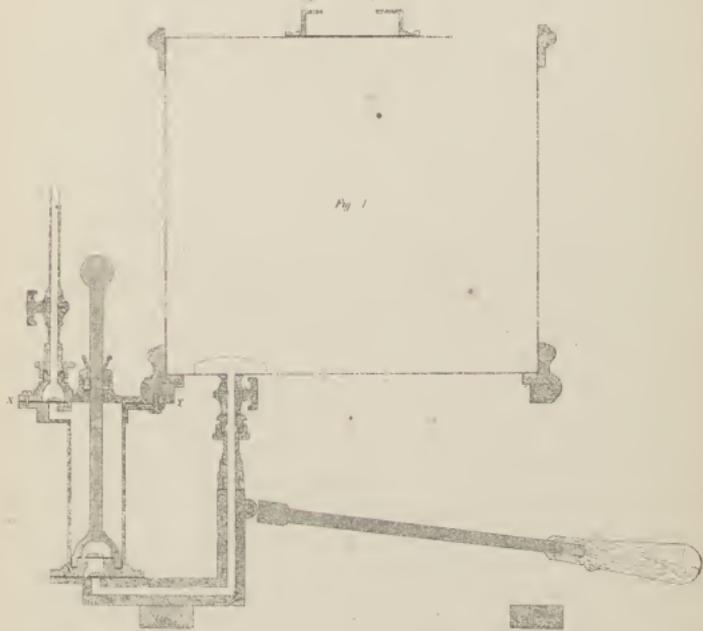
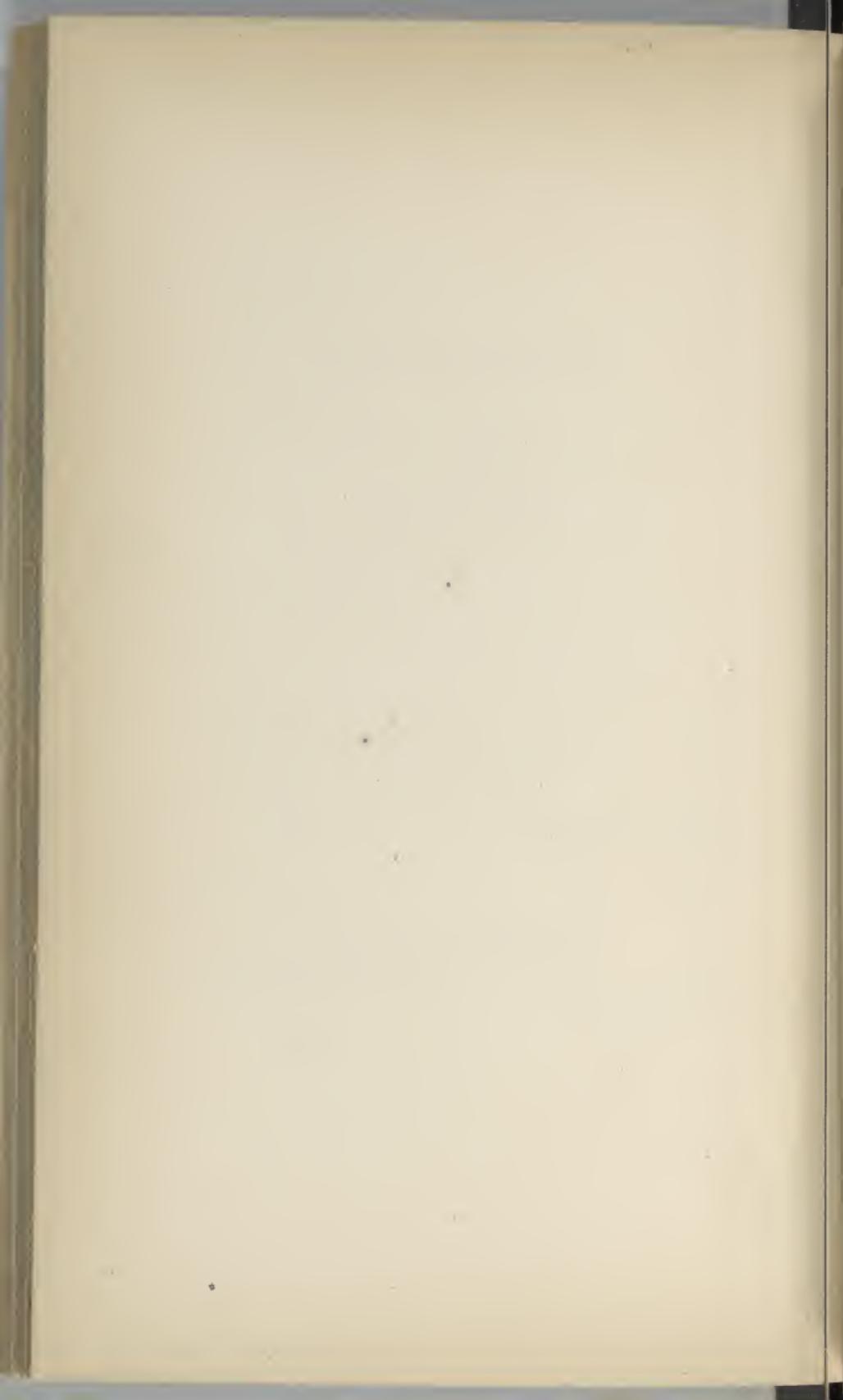


Fig. 1

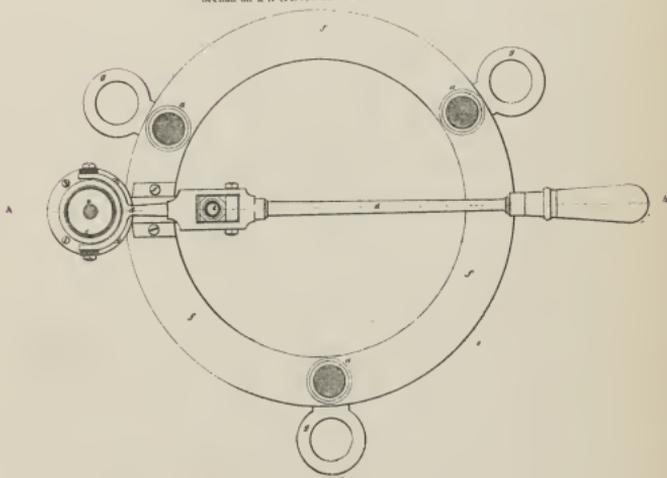




FIRST ORDER HYDRAULIC LAMP.

Plate N° V.

Section on K L. (Pl. L) 1/2" from K L to base



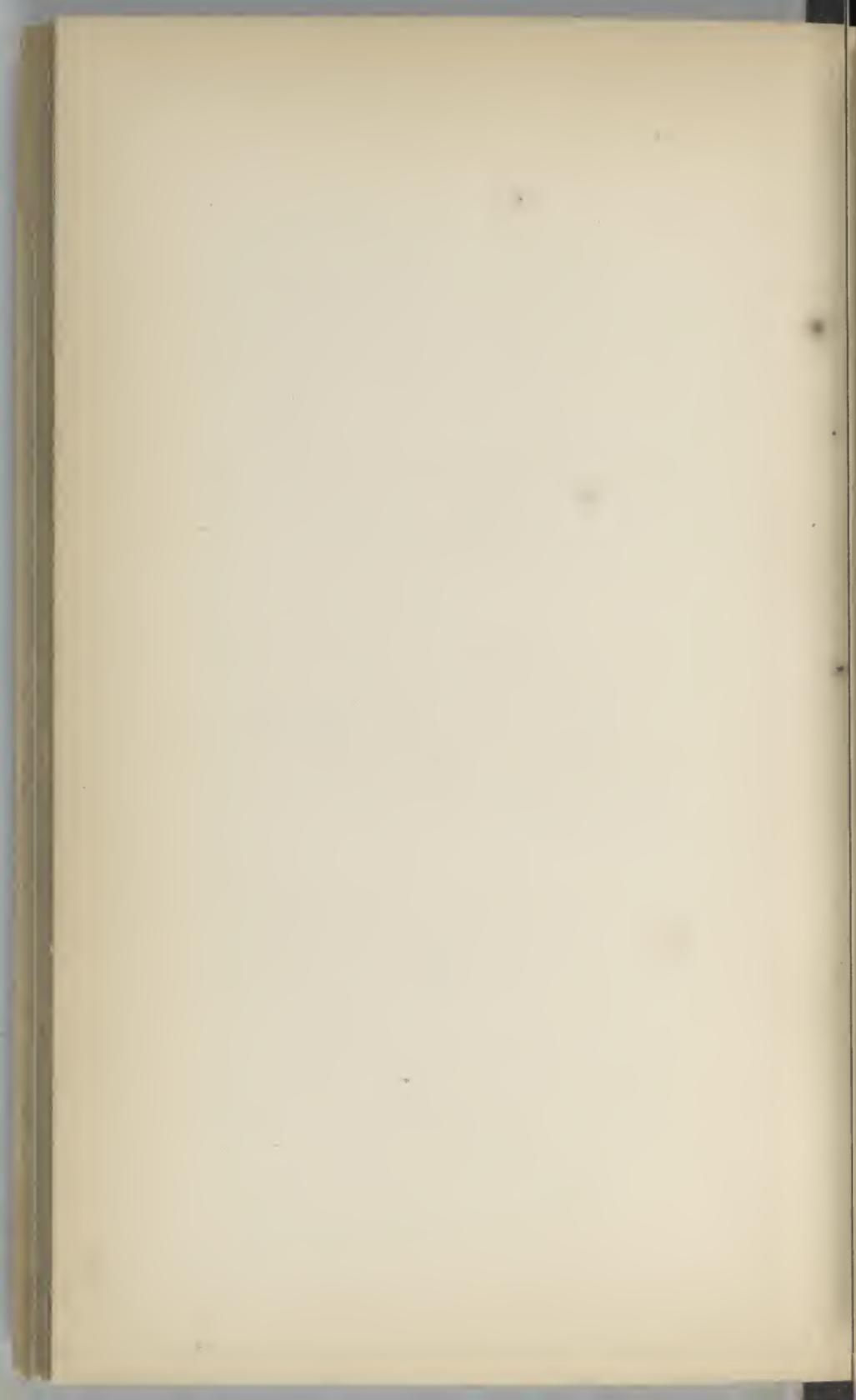


Fig. 1.
Section on AB (Pl. I.) Plan from AB to CD.

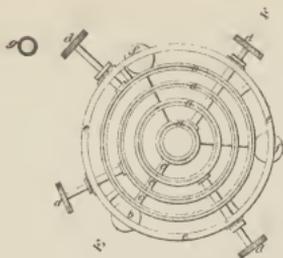


Fig. 2.
Section on CD (Pl. I.) Plan from CD to EF.

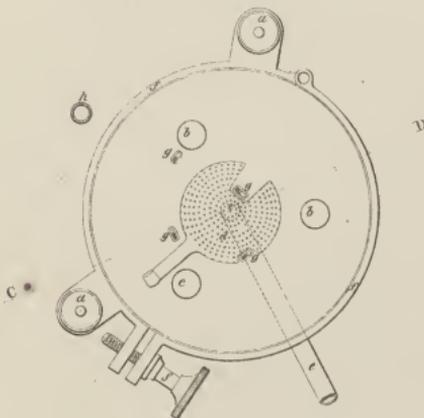
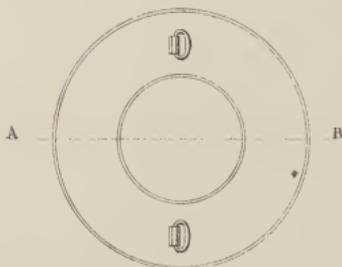
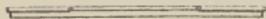


Fig. 3.
Movable cover of upper Reservoir.
PLAN.



Section on A.B



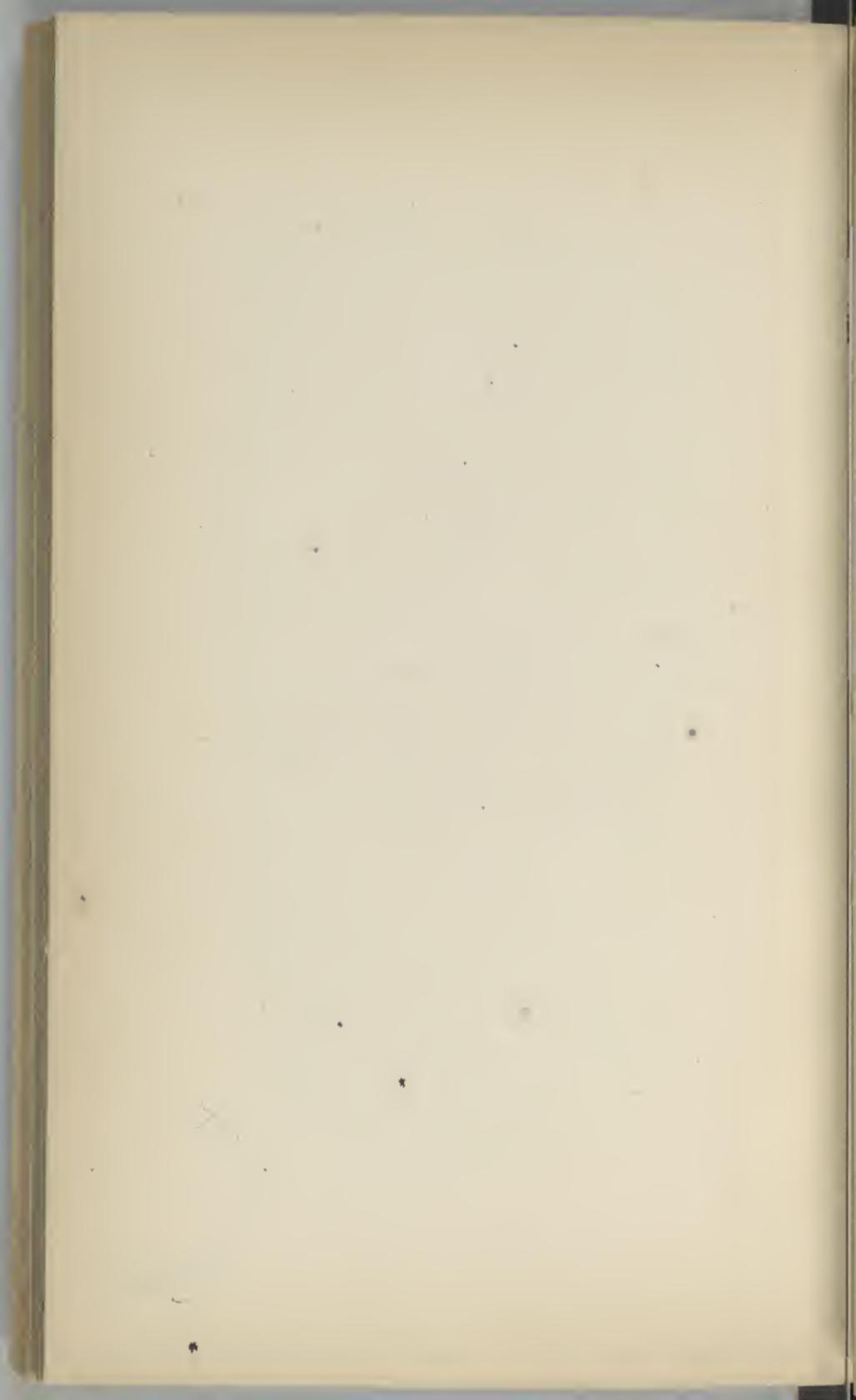
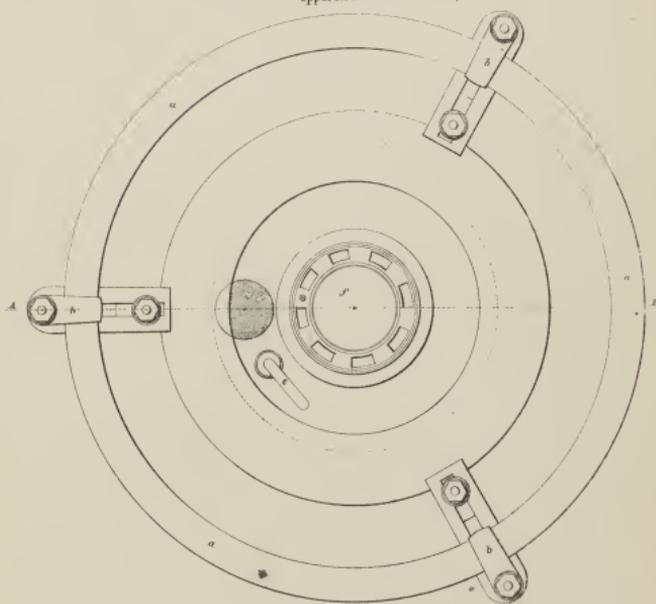
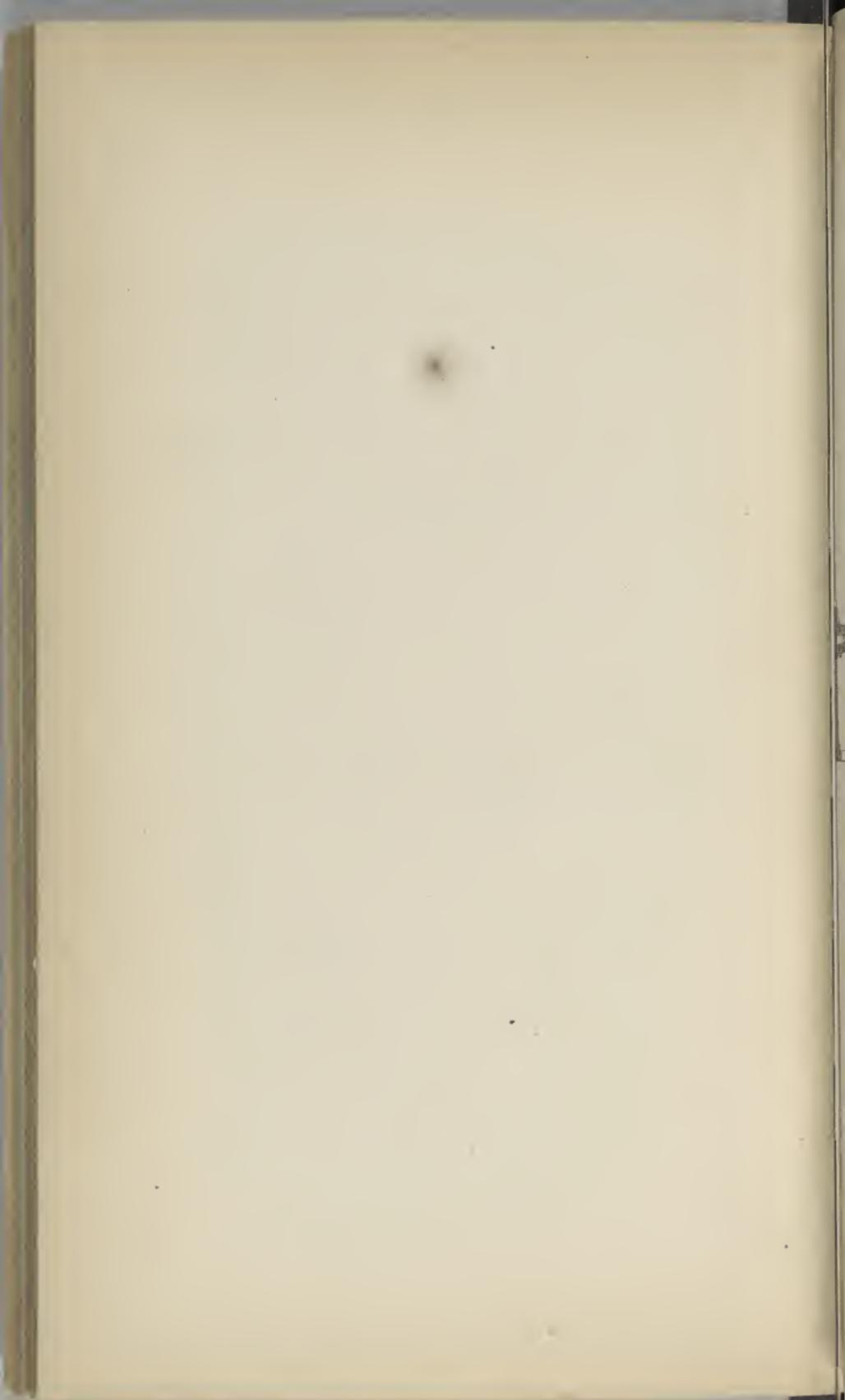


Plate No VII

FIRST ORDER HYDRAULIC LAMP.
Upper Reservoir

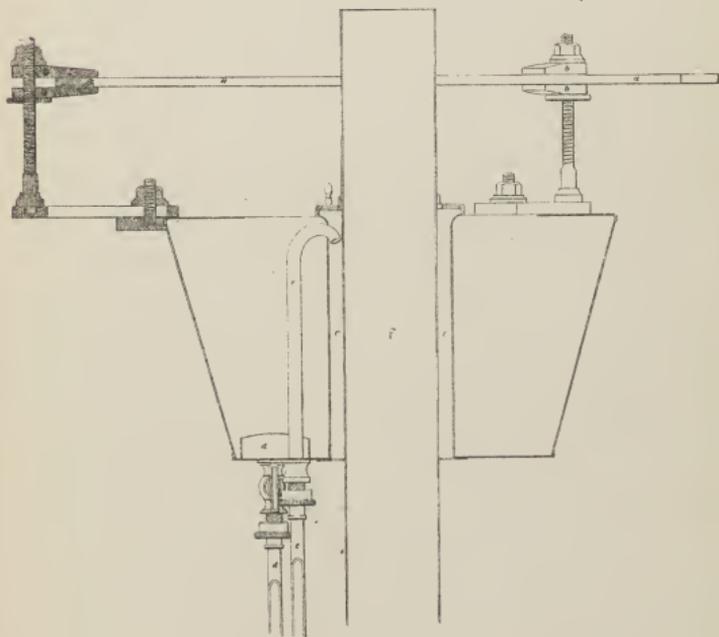


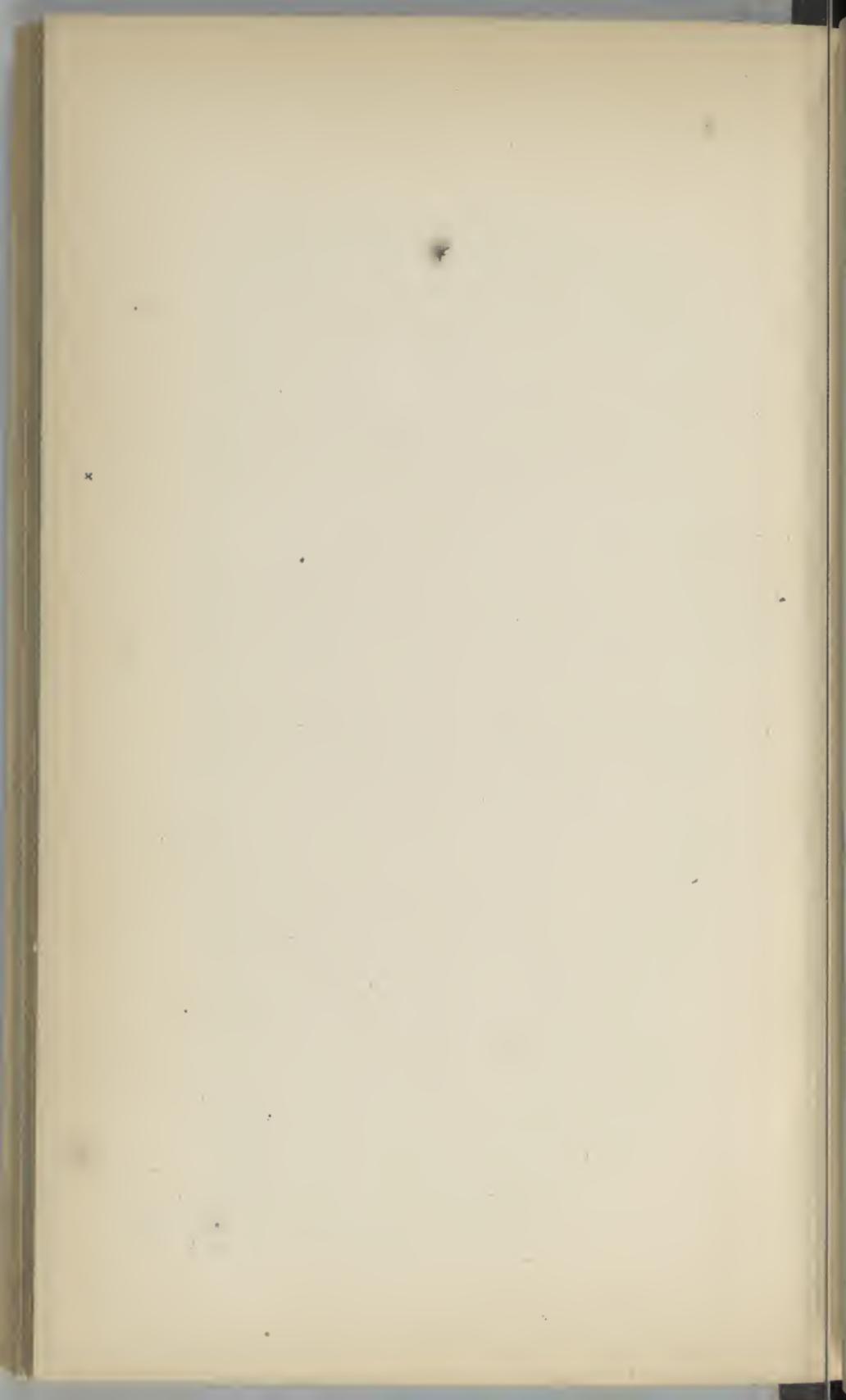


FIRST ORDER HYDRAULIC LAMP.

Plate N^o VII.

Fig 2
Section and Elevation on A B



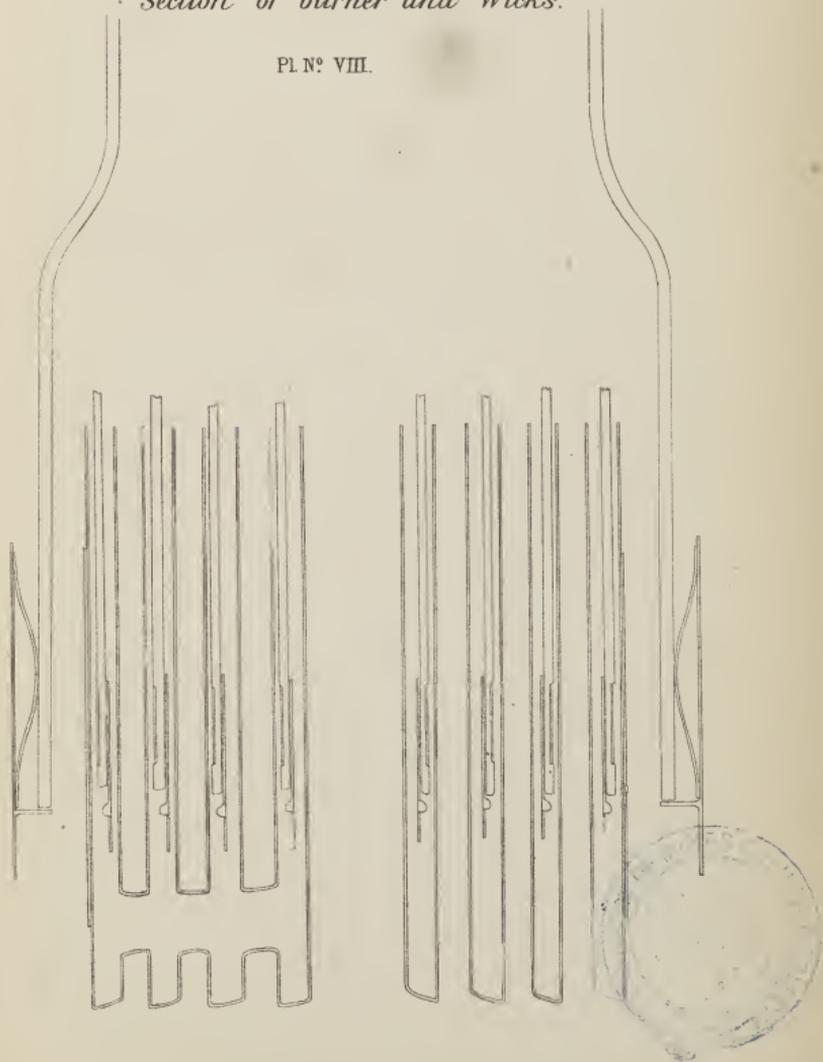


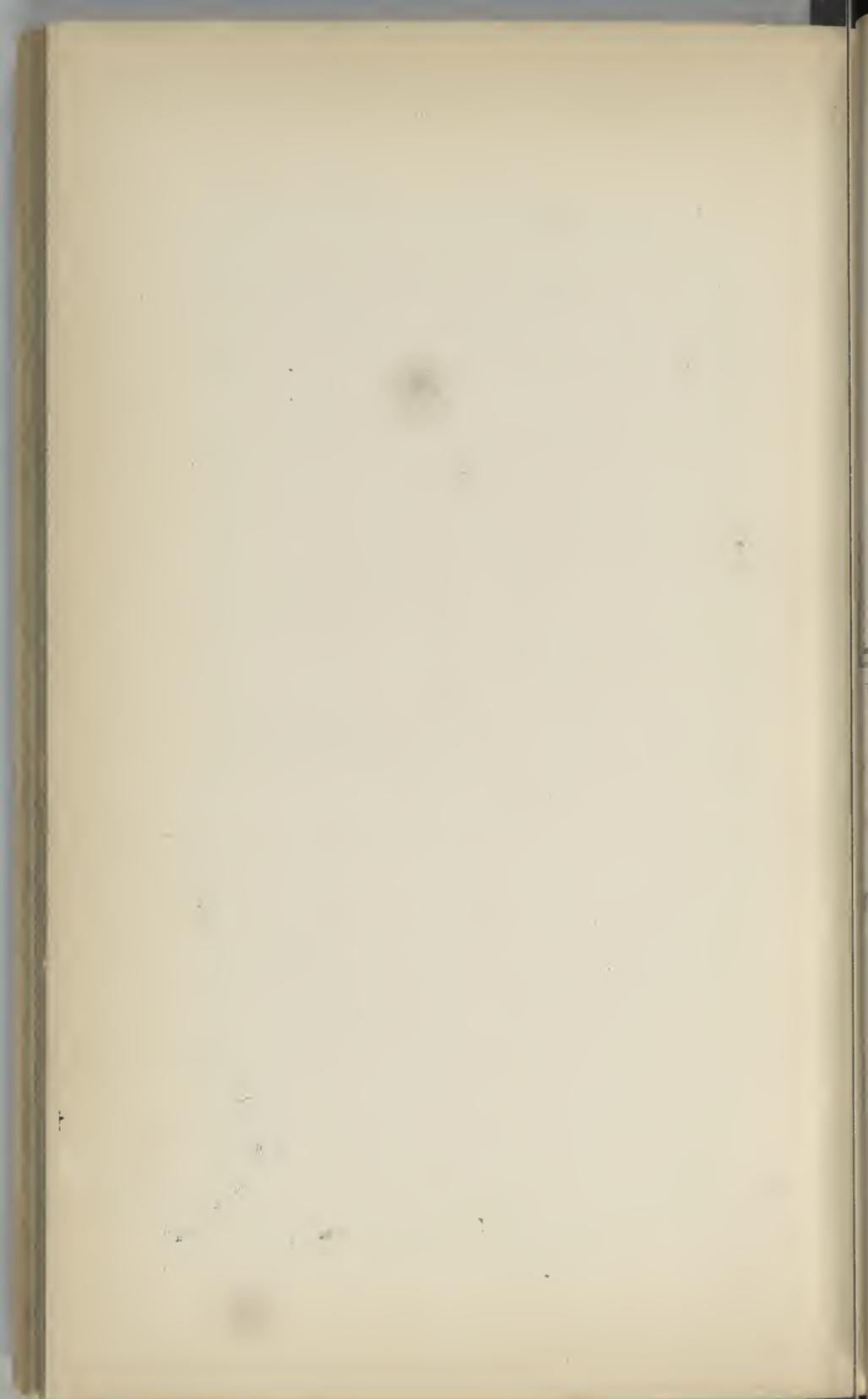
FIRST ORDER HYDRAULIC LAMP

Fig. 6.

Section of burner and Wicks.

PL N^o. VIII.





FIRST ORDER HYDRATIC LAMP.

Details.

Figs. 1, 2, 3, 4 & 5.

Fig. 4.

Section through pipe m & valve i.

Pl. III.

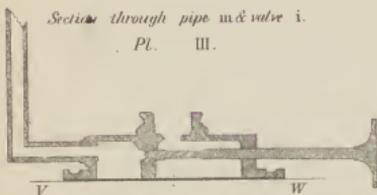


Fig. 5.

Inverted Plan, on V W.

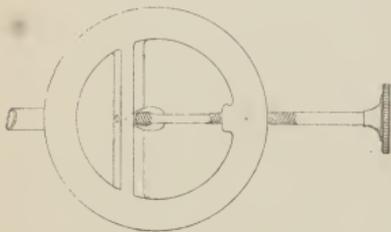
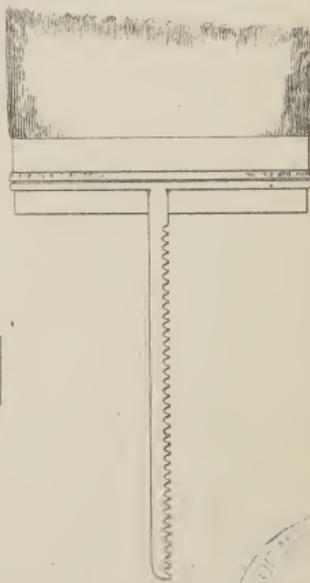
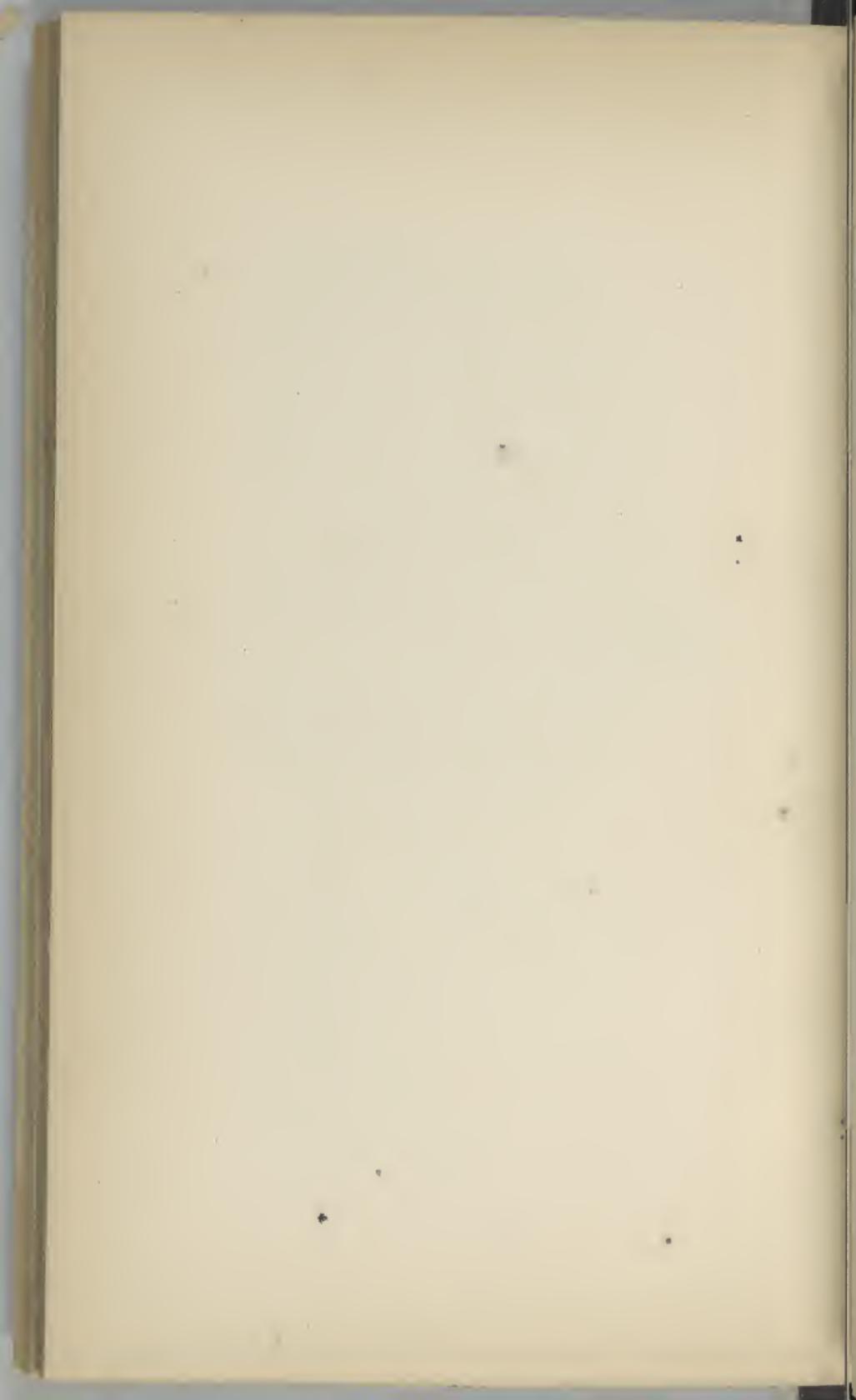


Fig. 7.

Elevation of Wick holder

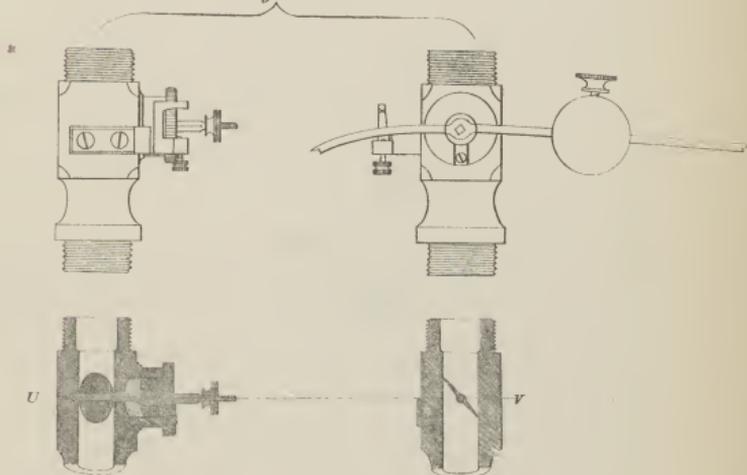


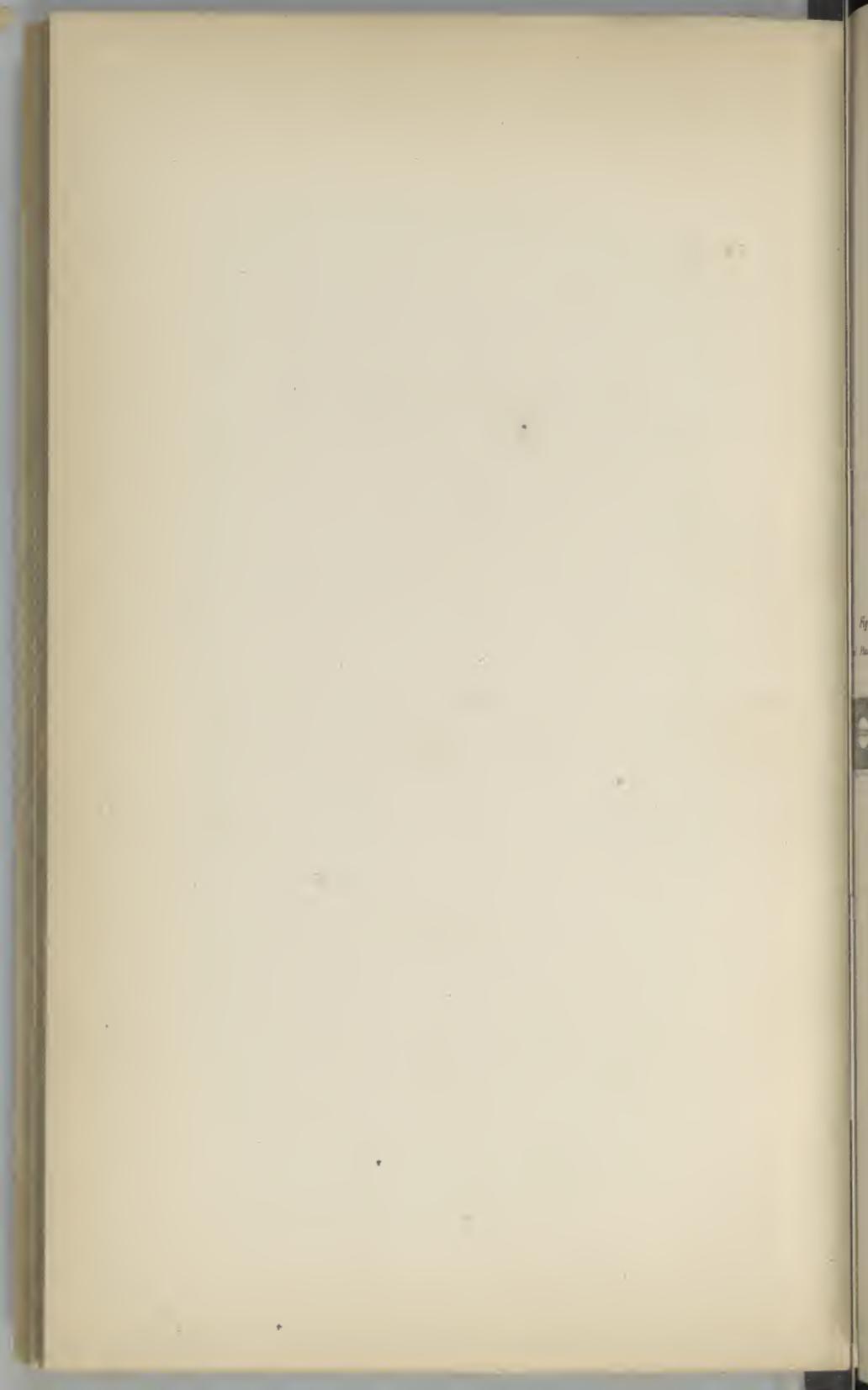


FIRST ORDER HYDRAULIC LAMP.

Elevation and Section of Valve box.

Fig. 8





FIRST ORDER HYDRAULIC LAMP.

Fig. 9.

Sectional Plan of Valve box, through U V.

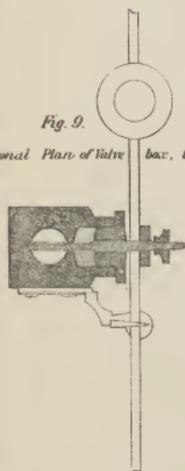


Fig. 10.

Leather Washer and valve on X Y (Fig. 1.)

Plan

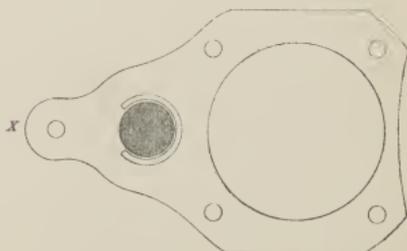


Fig. 11.

Section on X Y.



Sections of

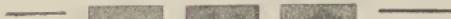
Tin.

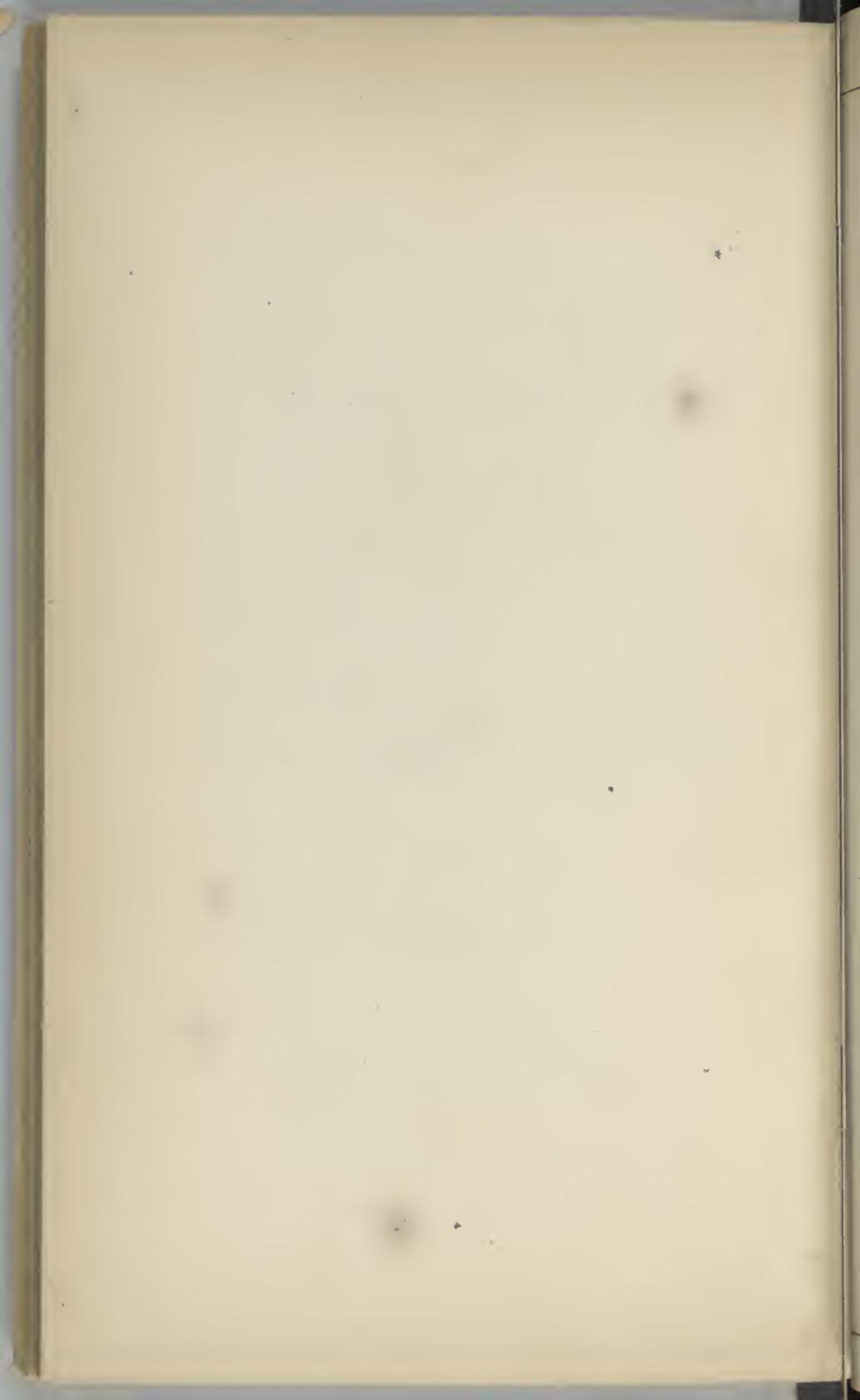
Iron

Brass

Lead

Leather.

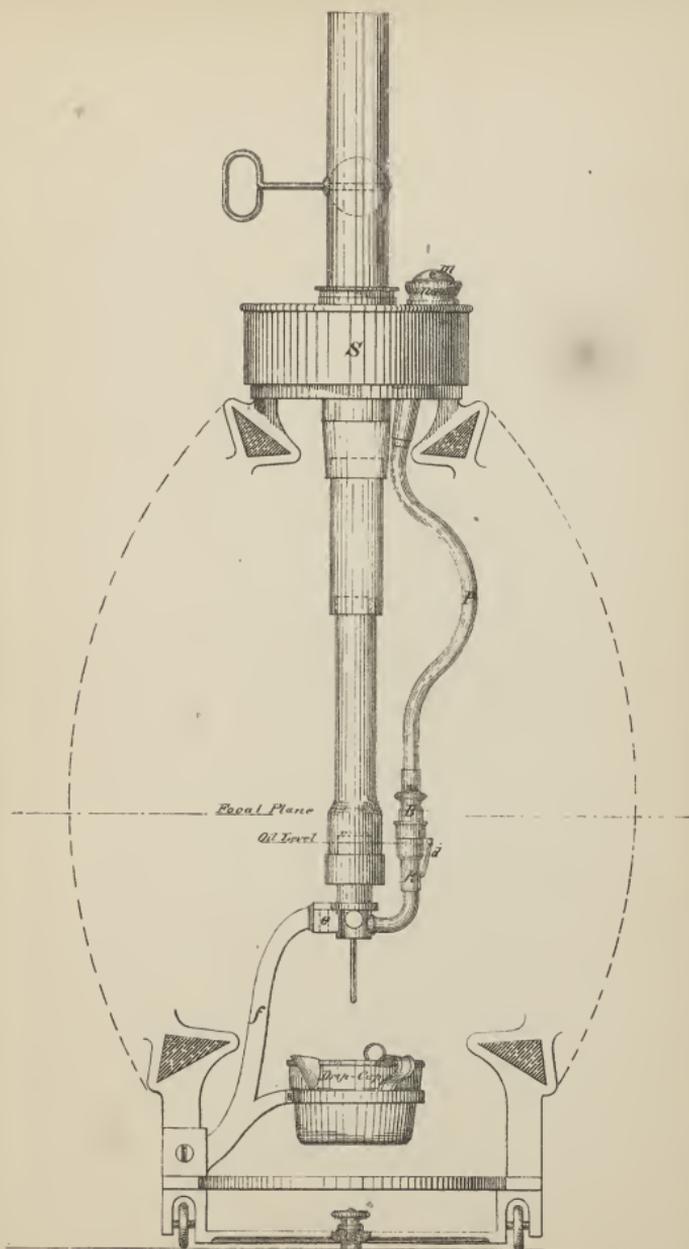




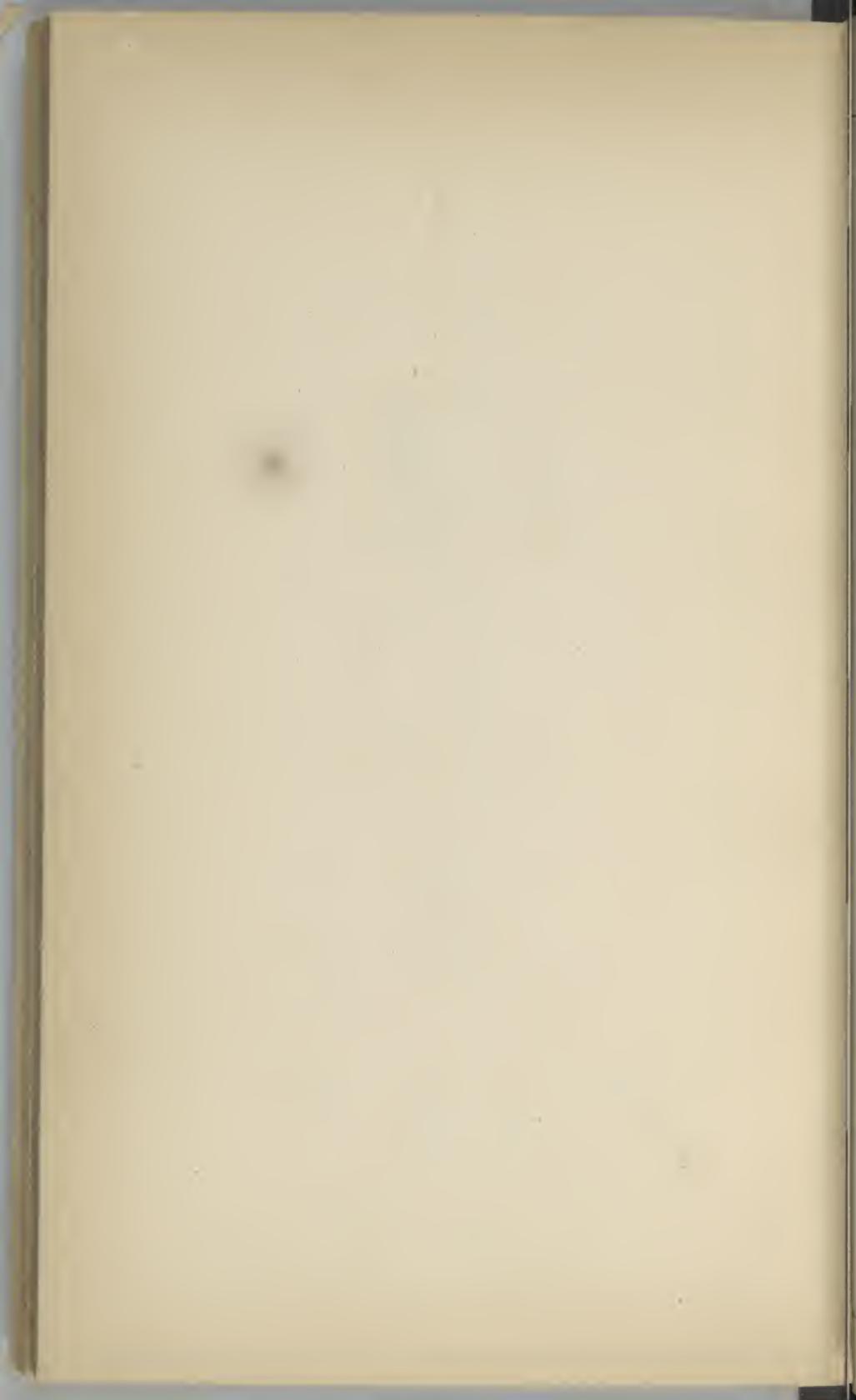
FRANKLIN LAMP.

PLATE I.

FOR 4th ORDER LENS APPARATUS



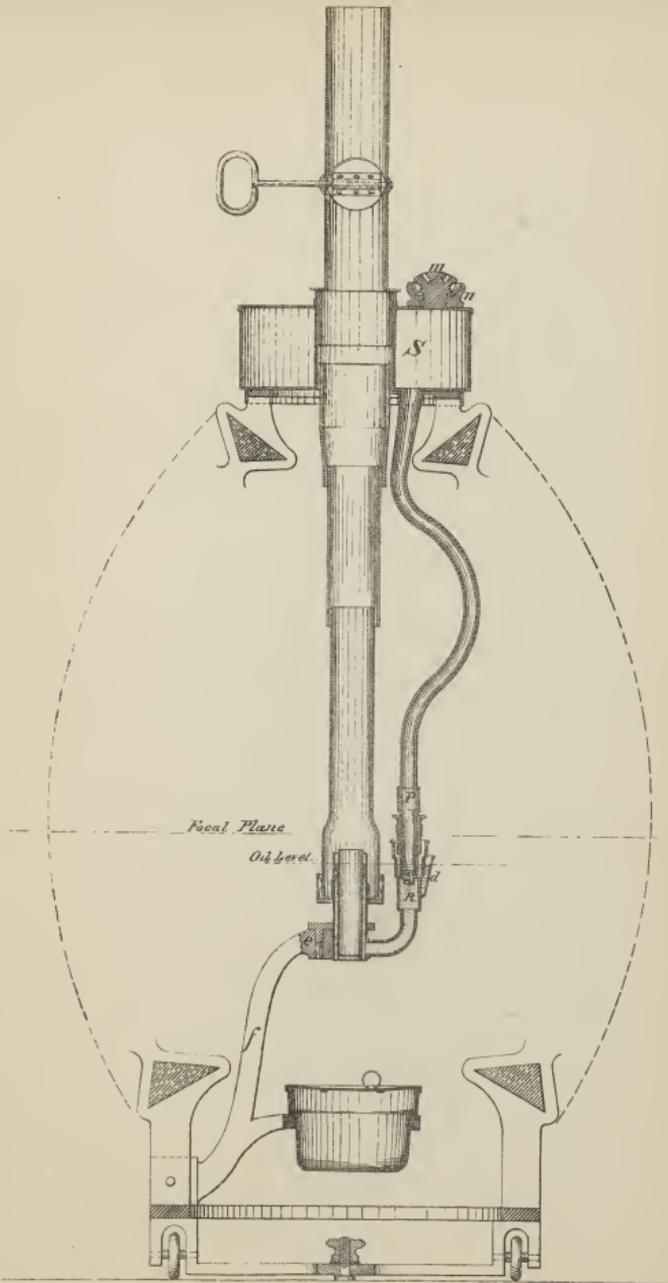
Elevation.



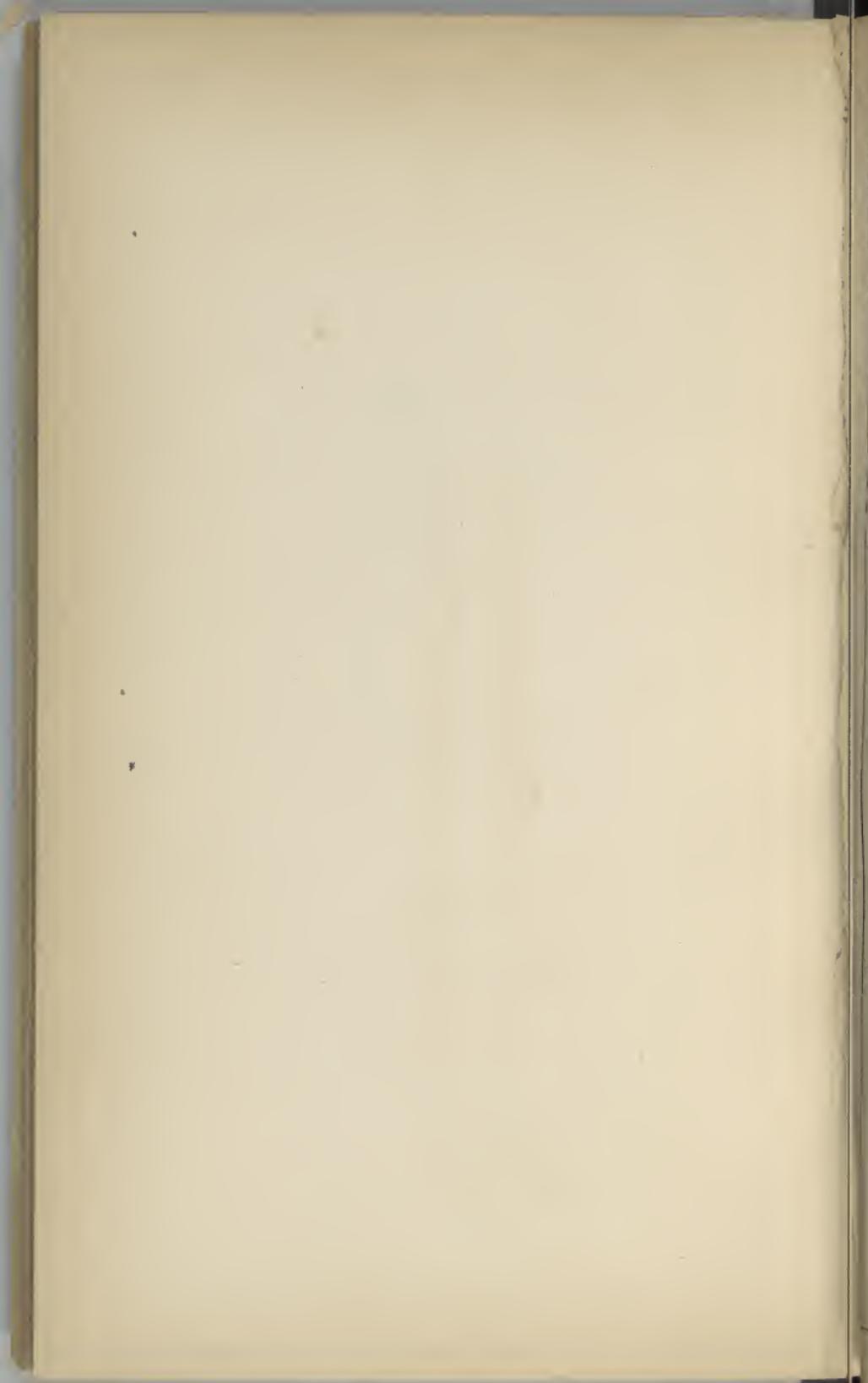
FRANKLIN LAMP.

PLATE 2.

FOR 4" ORDER LENS APPARATUS



Section.

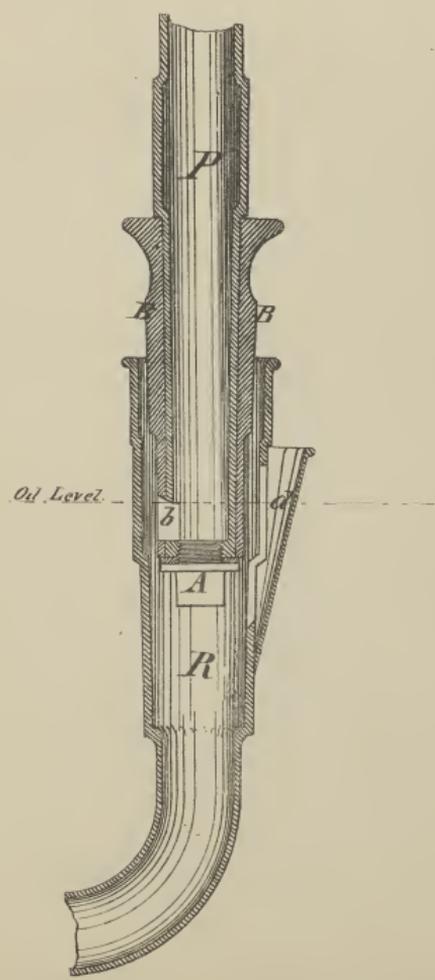


FOR 4." ORDER LENS APPARATUS

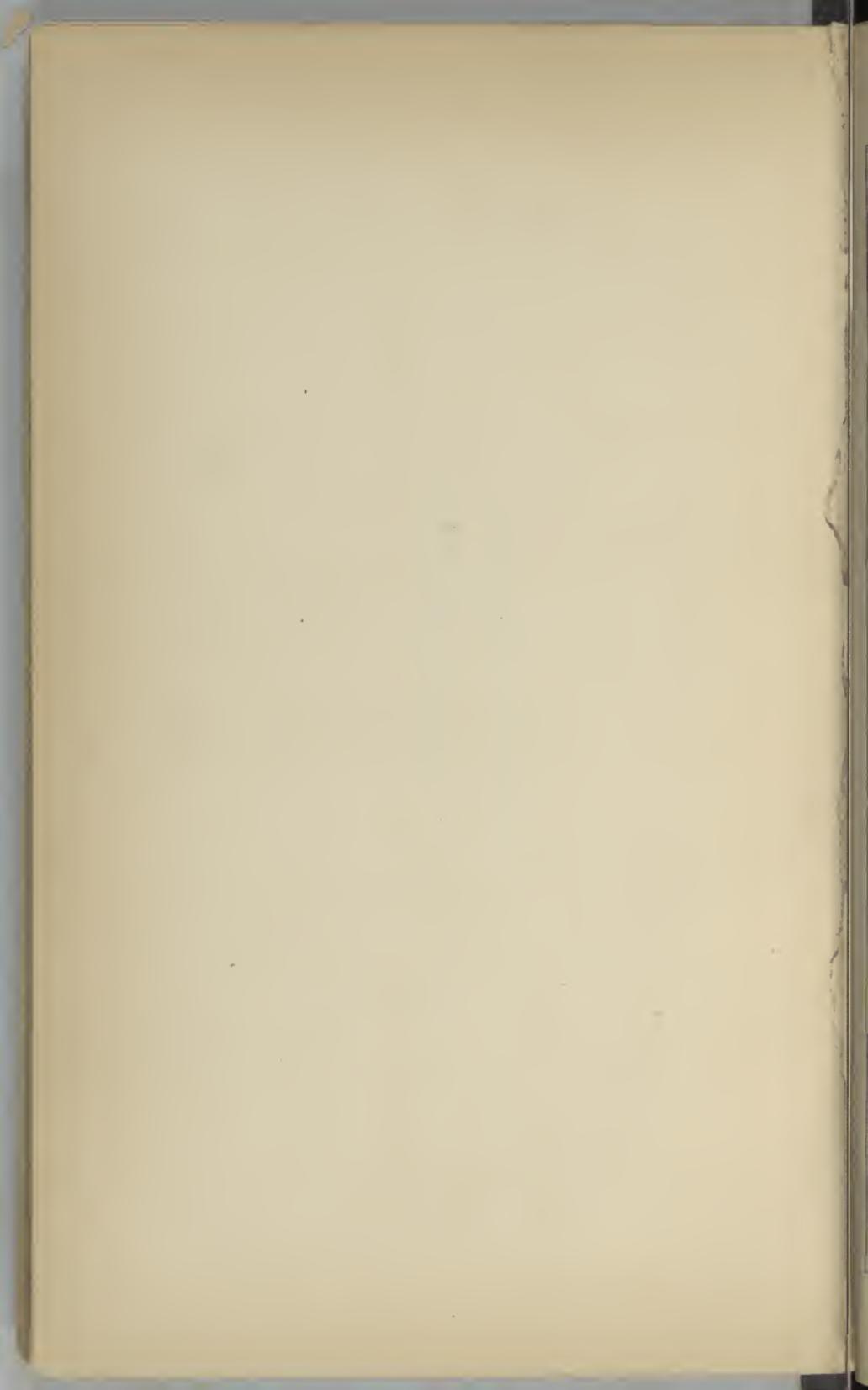


Plan of Cock

Full Size.



Section through the Cock.

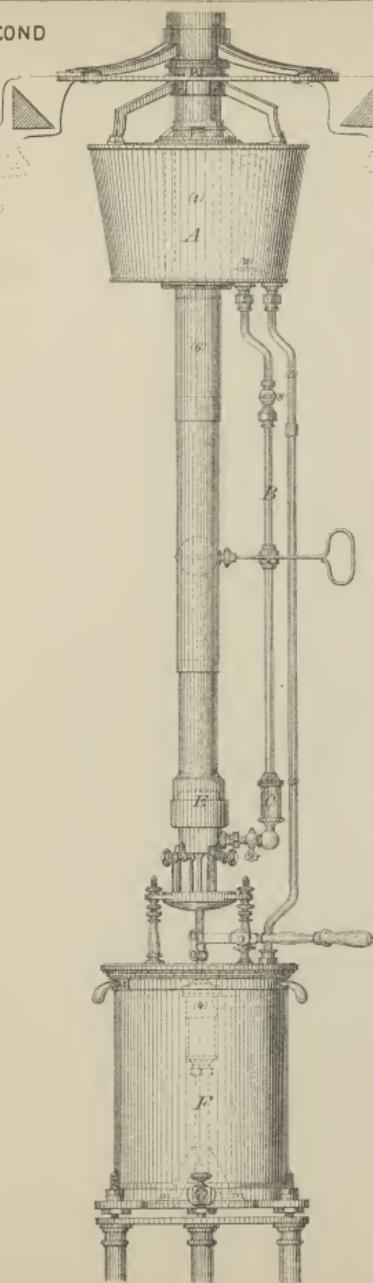


FUNCK'S HYDRAULIC FLOAT LAMP

PLATE 1.

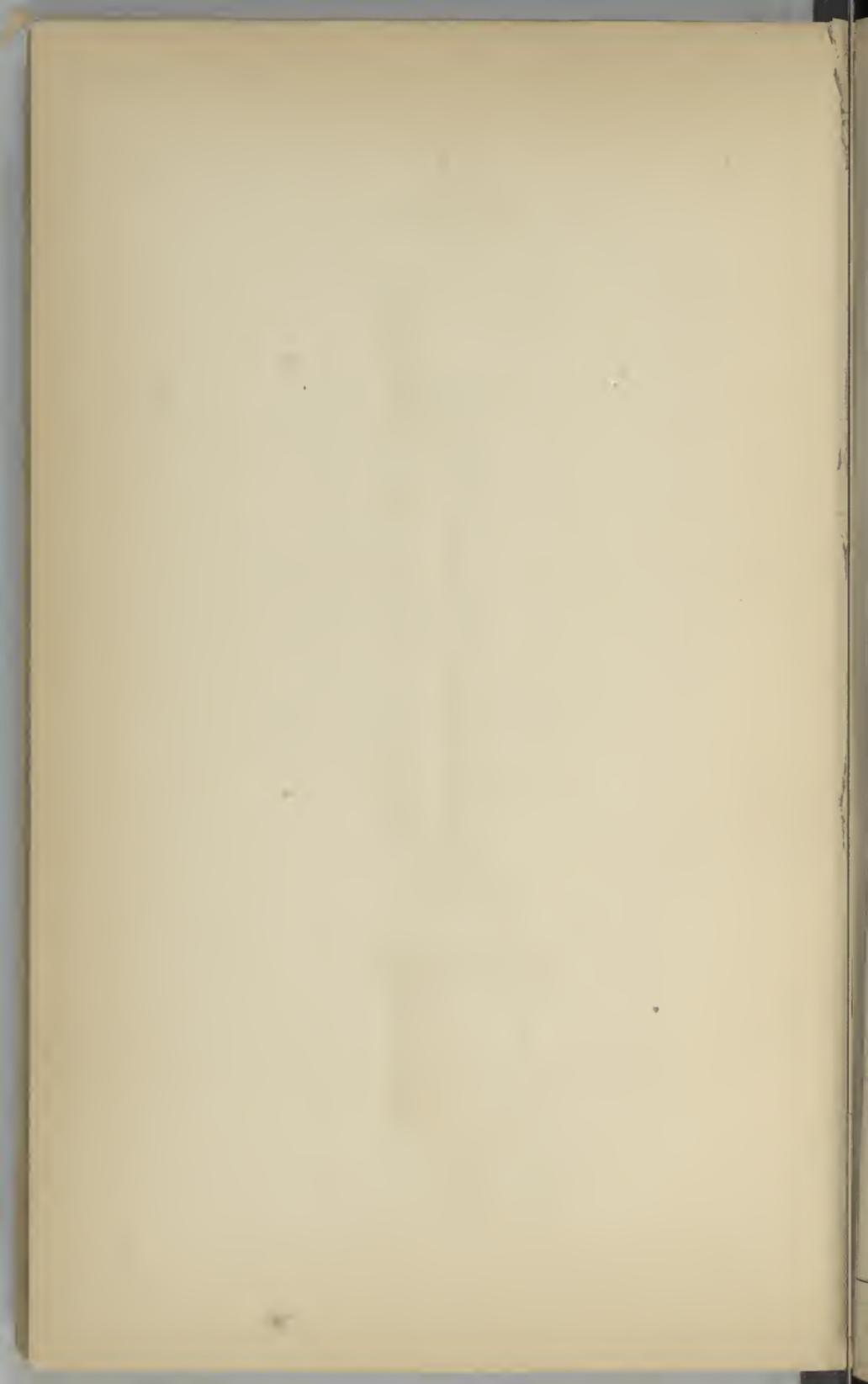
FIRST and SECOND

ORDER LAMP.



12 9 6 3 0 1 2 3

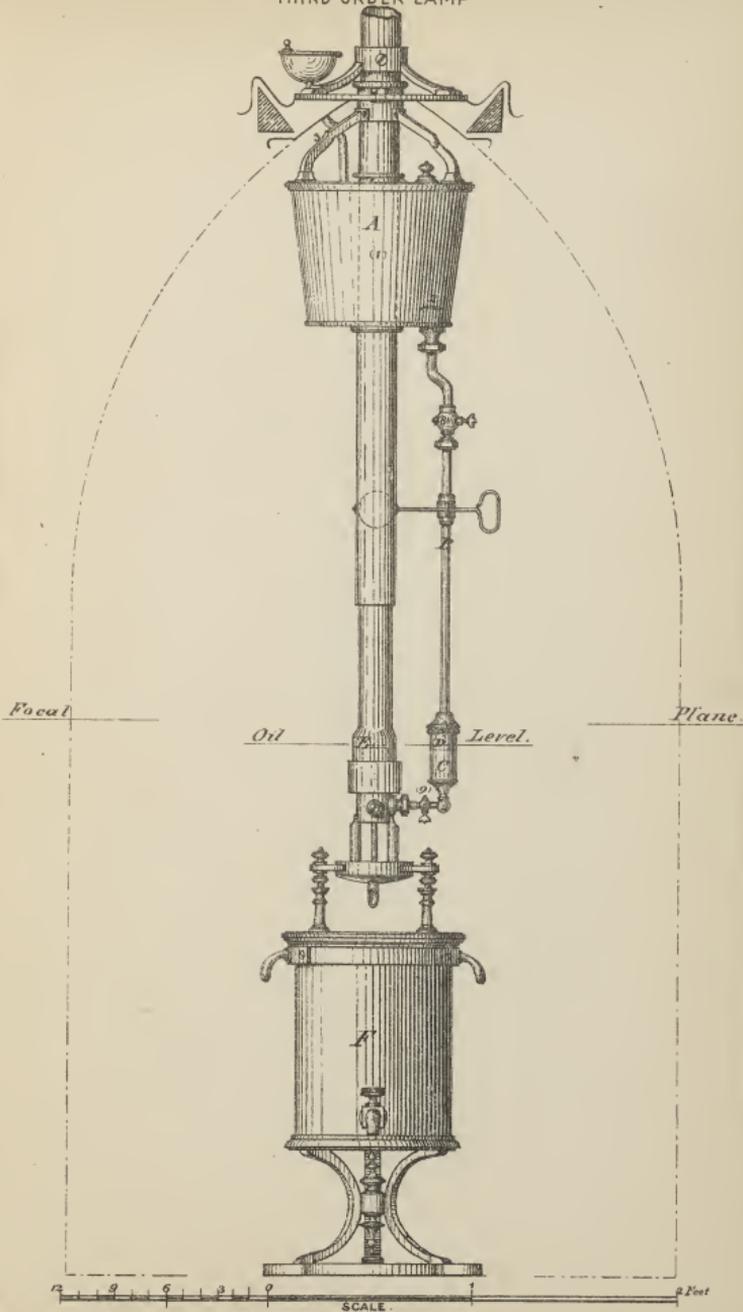
SCALE

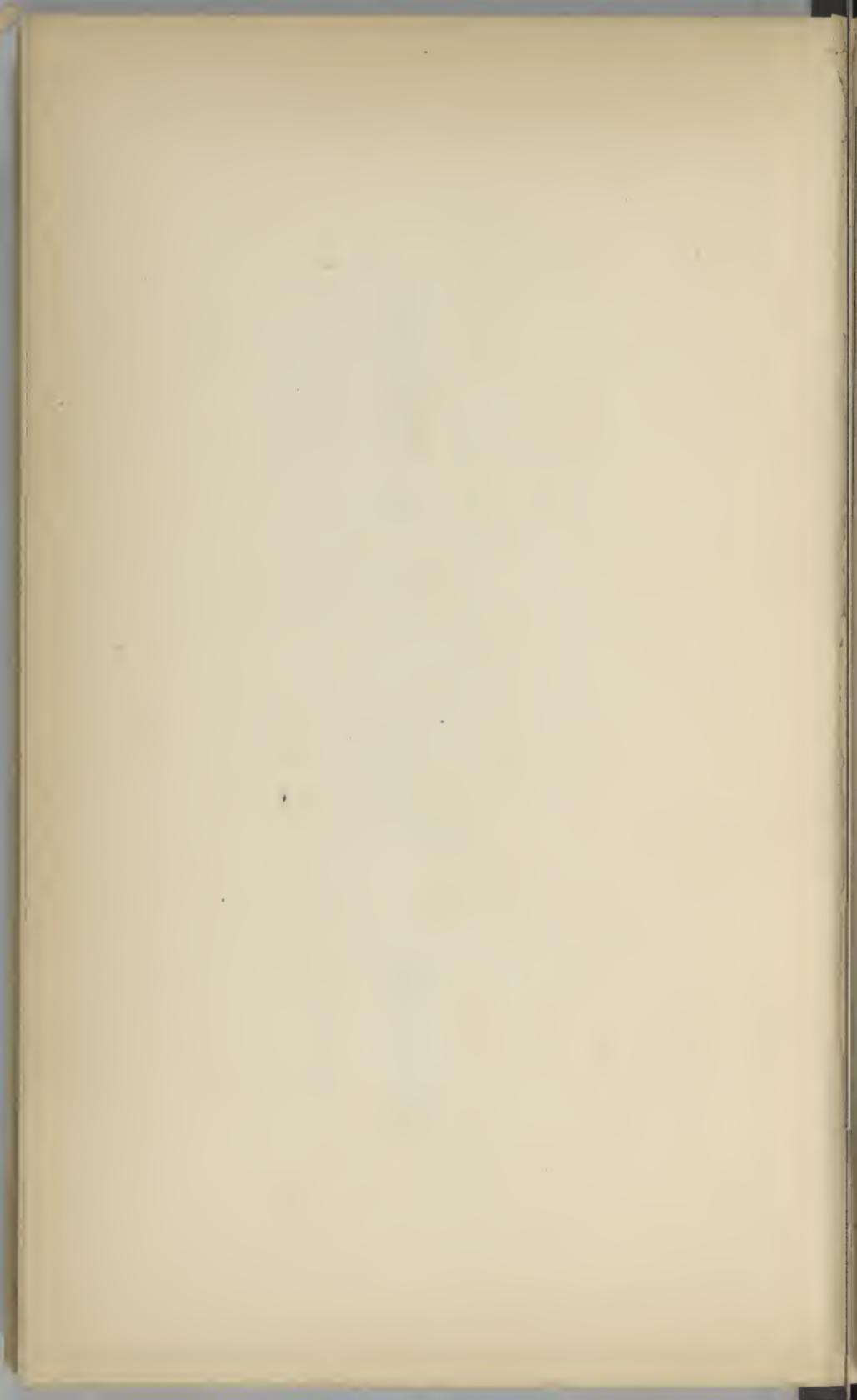


FUNCK'S HYDRAULIC FLOAT LAMP

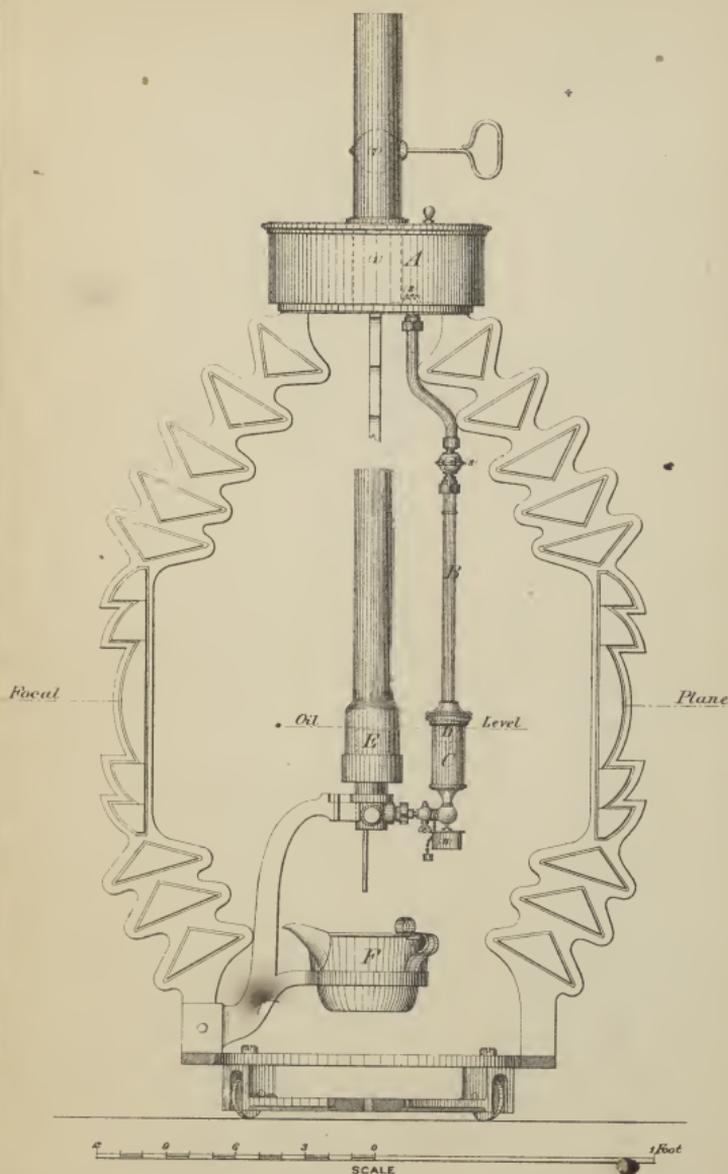
PLATE 2.

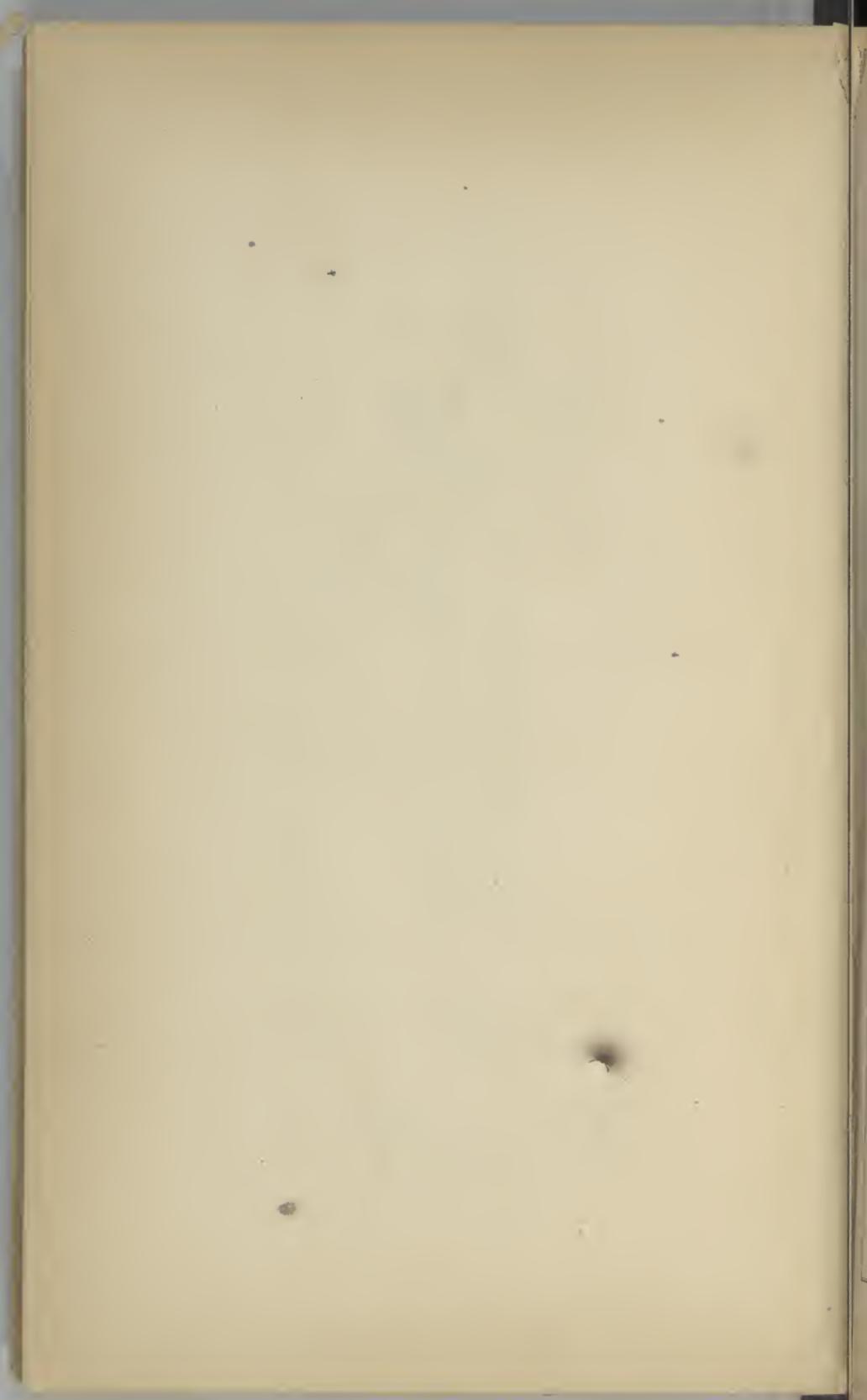
THIRD ORDER LAMP



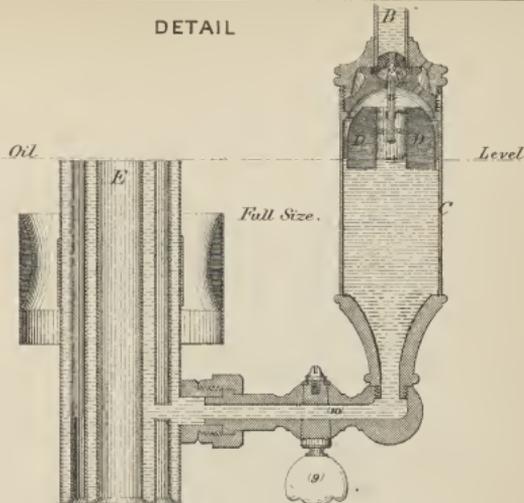


FOURTH, FIFTH & SIXTH ORDER LAMP.



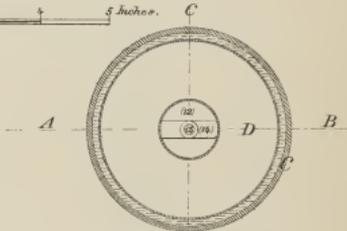


DETAIL

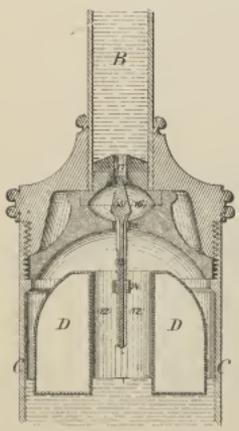


Full Size.

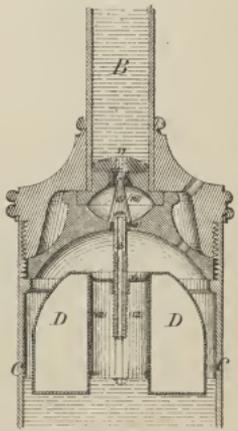
Section through Float chamber C.



Horizontal Section



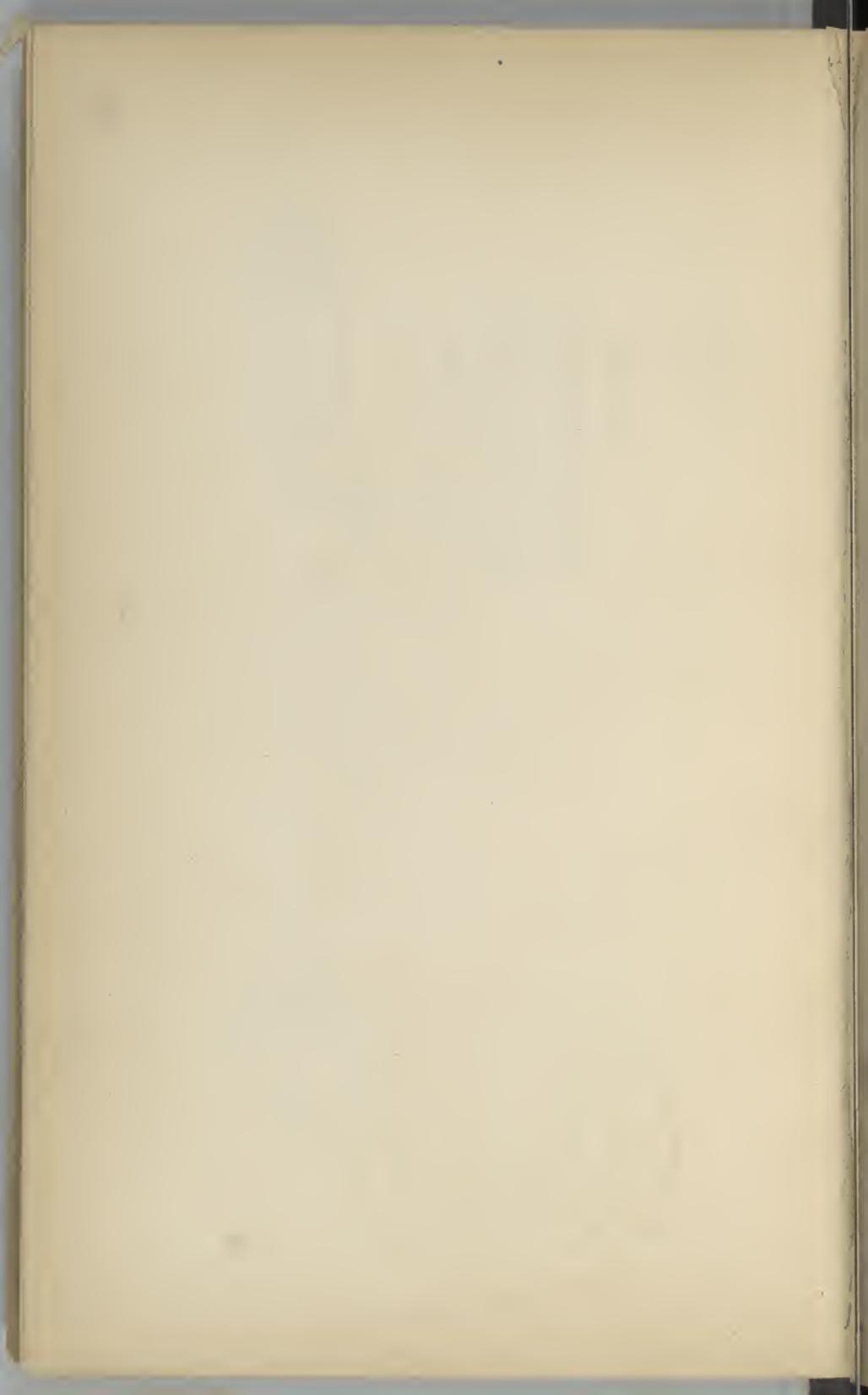
Vertical Section on CD.



Vertical Section on AB.

SCALE

3 Inches.



*First order
Burner and
Flame. 4 Wicks.*

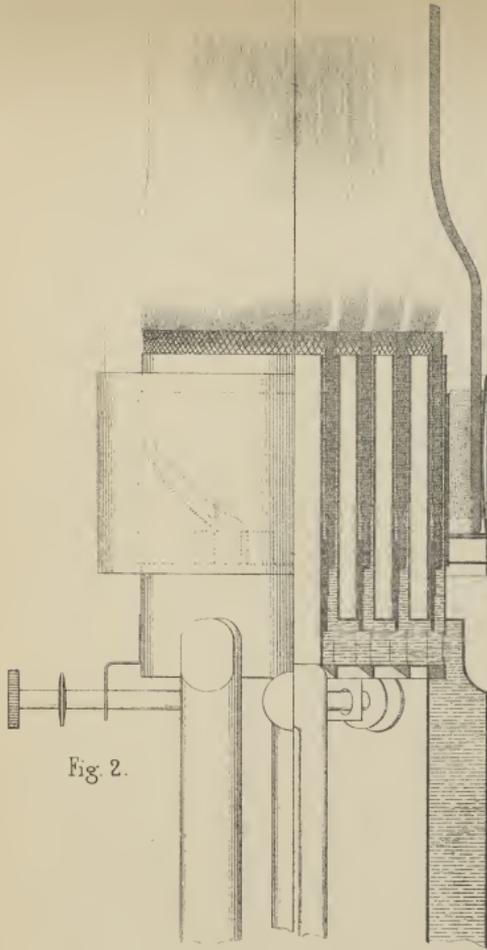


Fig. 2.

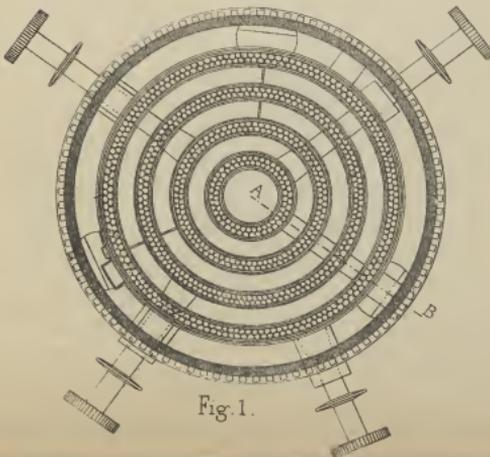
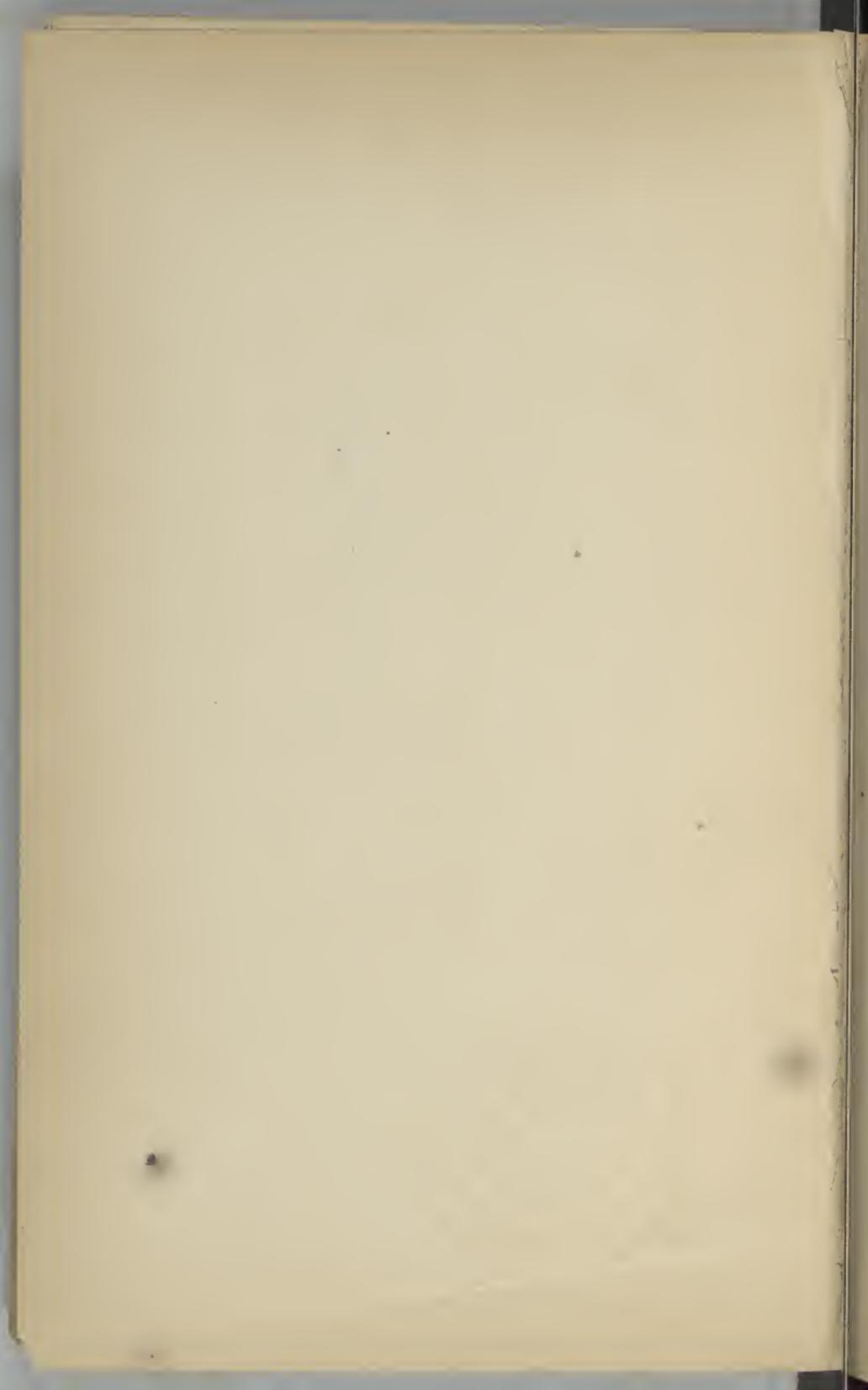


Fig. 1.

Fig. 1 is the plan of a 1st order Burner, seen from above and Fig. 2 represents on one side the elevation, and on the other the section through the line A B of the Plan.



*Second order Burner
and Flame - 3 Wicks.*

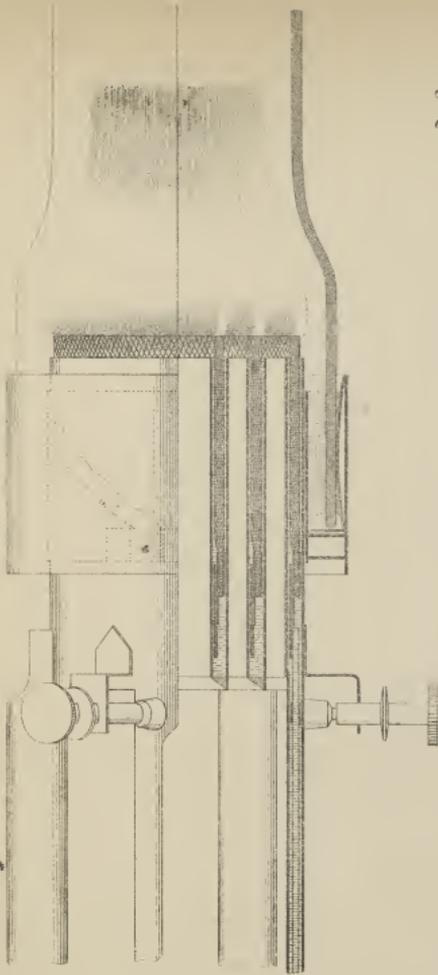


Fig. 4.

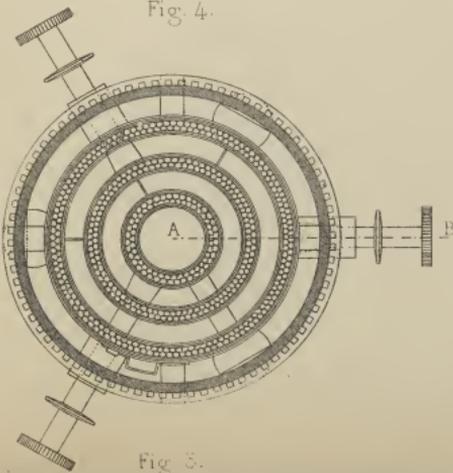
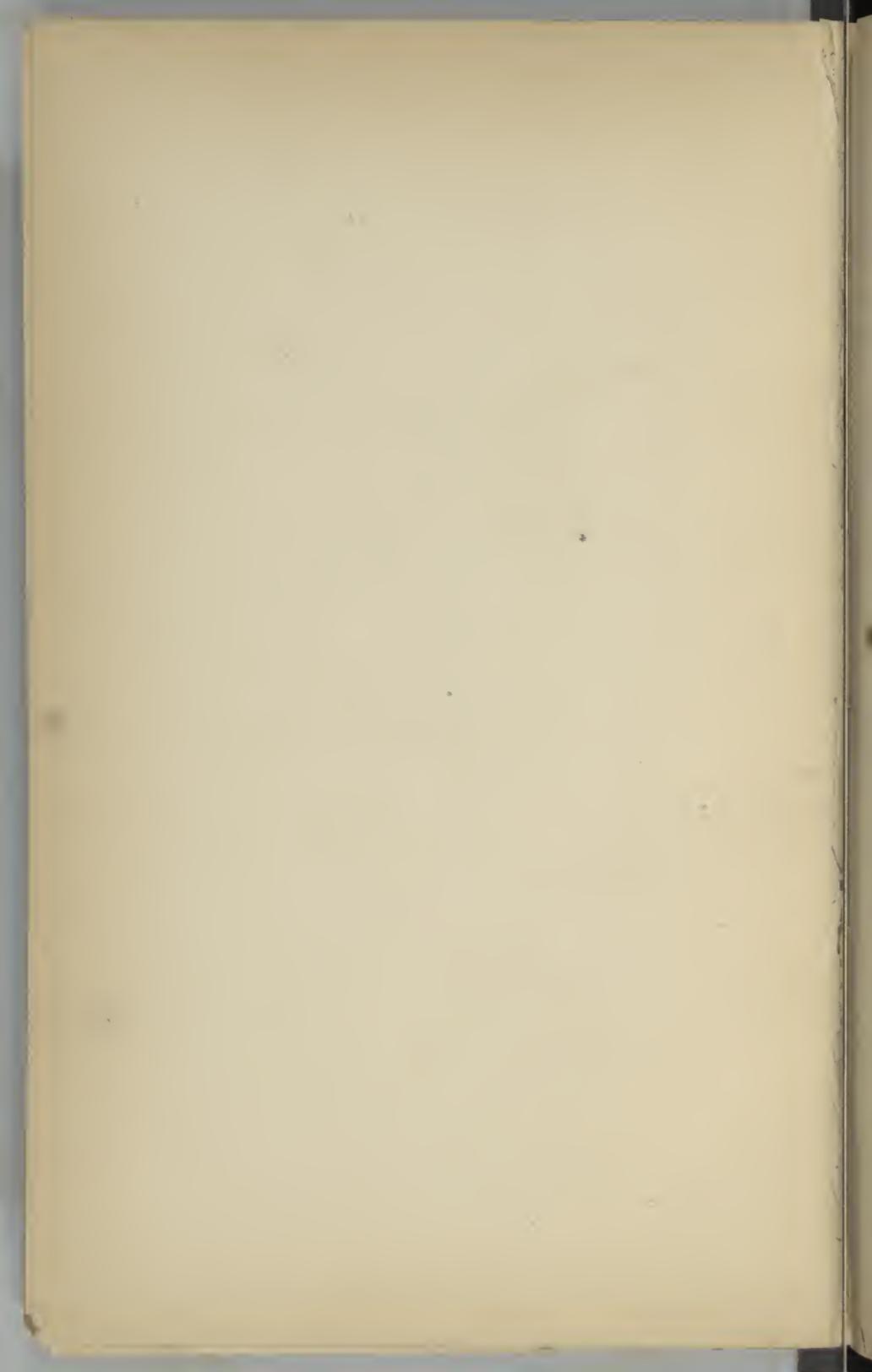


Fig. 5.

*Fig. 3 and 4, 5 and 6, and 7 and 8 represent respectively the plans,
elevations and sections of the burners and flames of the second,
third and fourth order Lamps*



*Third order Burner
and Flame - 2 Wick*

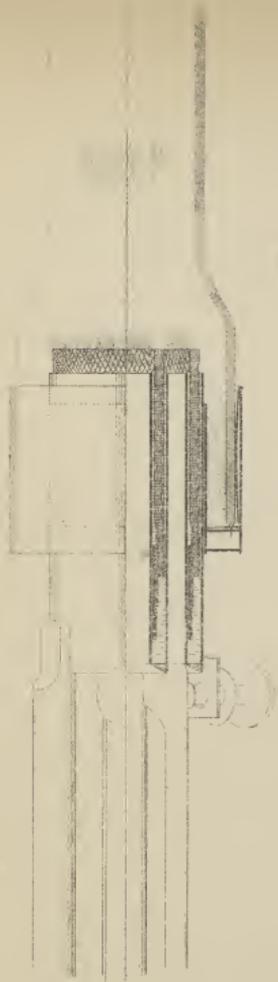


Fig 6

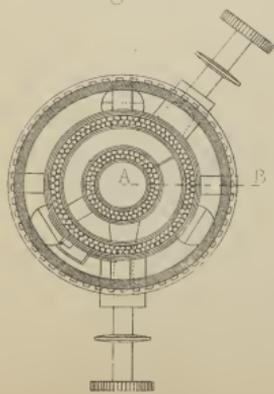
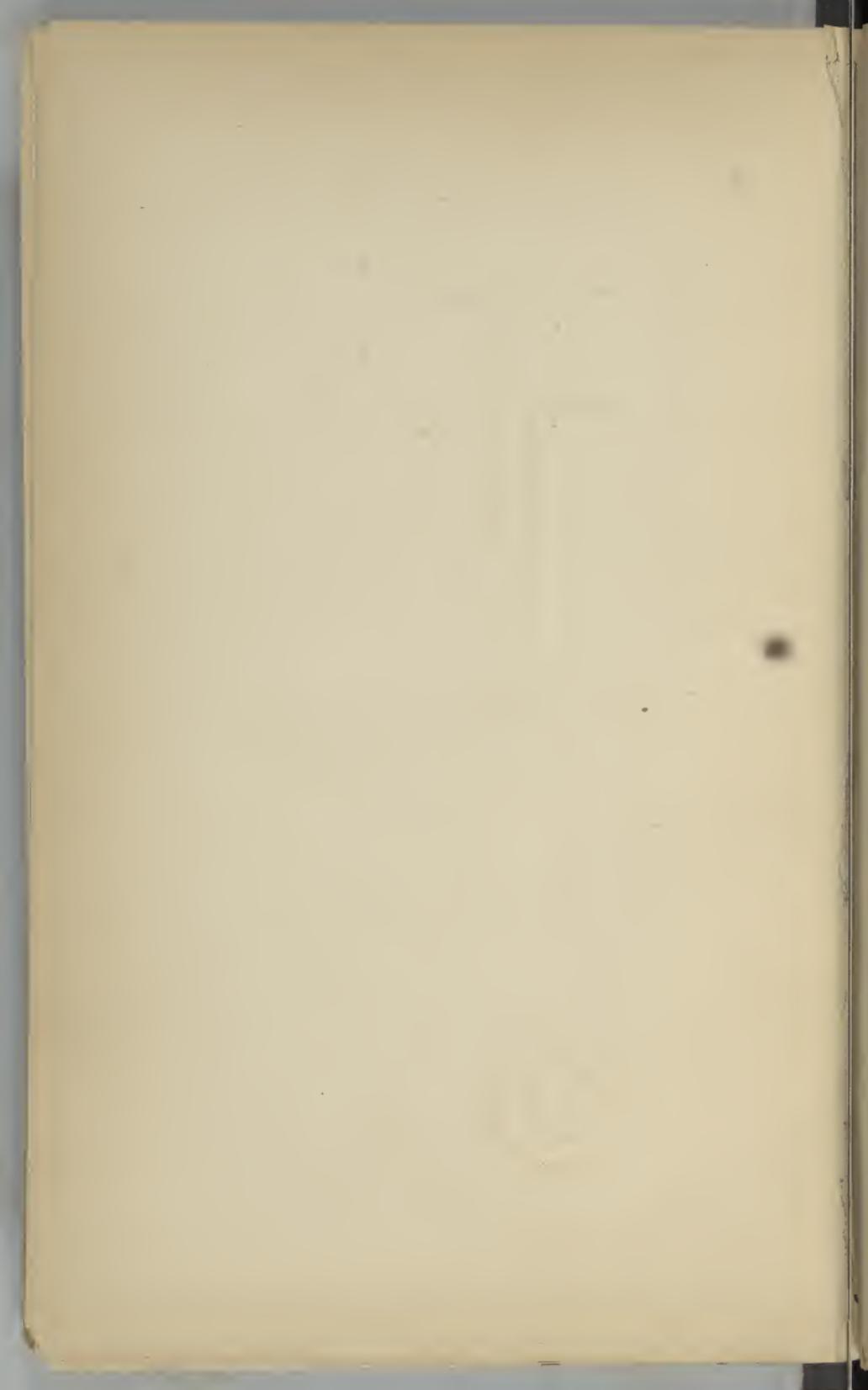


Fig. 5.



*Fourth order Burner and
Flame - 1 Wick
Constant level Lamp*

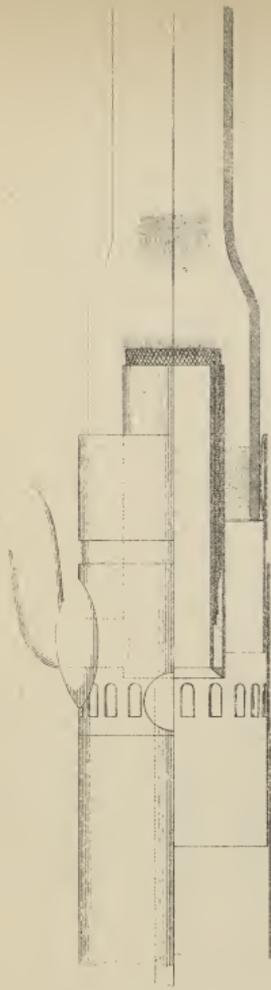


Fig 8

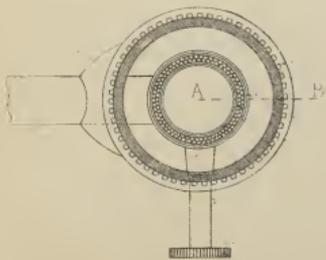
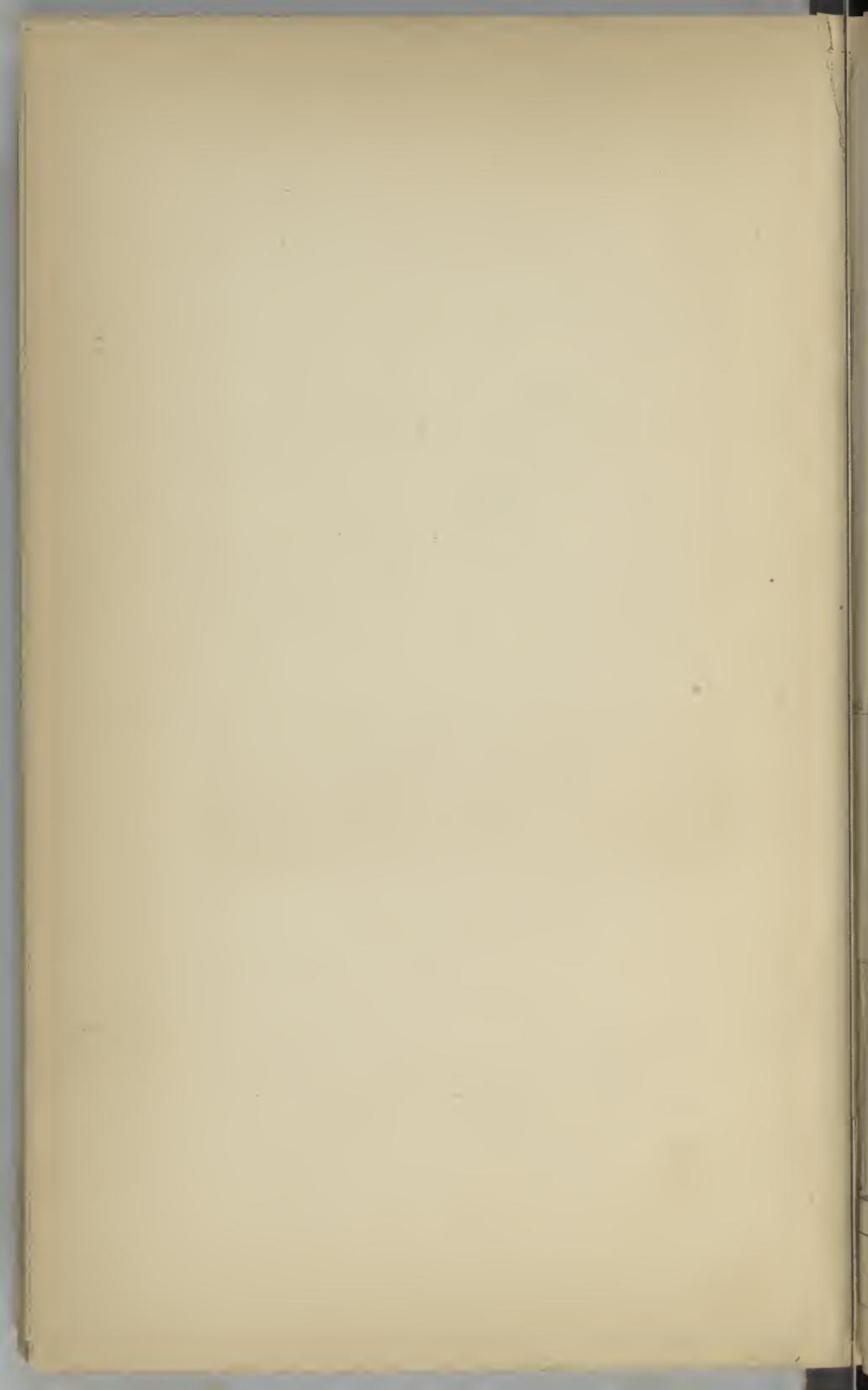


Fig 7



Chimney 13 $\frac{3}{4}$ inches.

Flame fully developed.

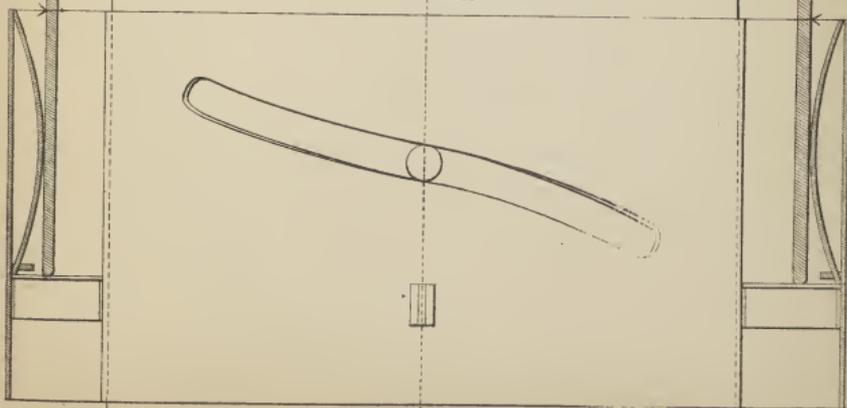
3 $\frac{1}{4}$ inches.

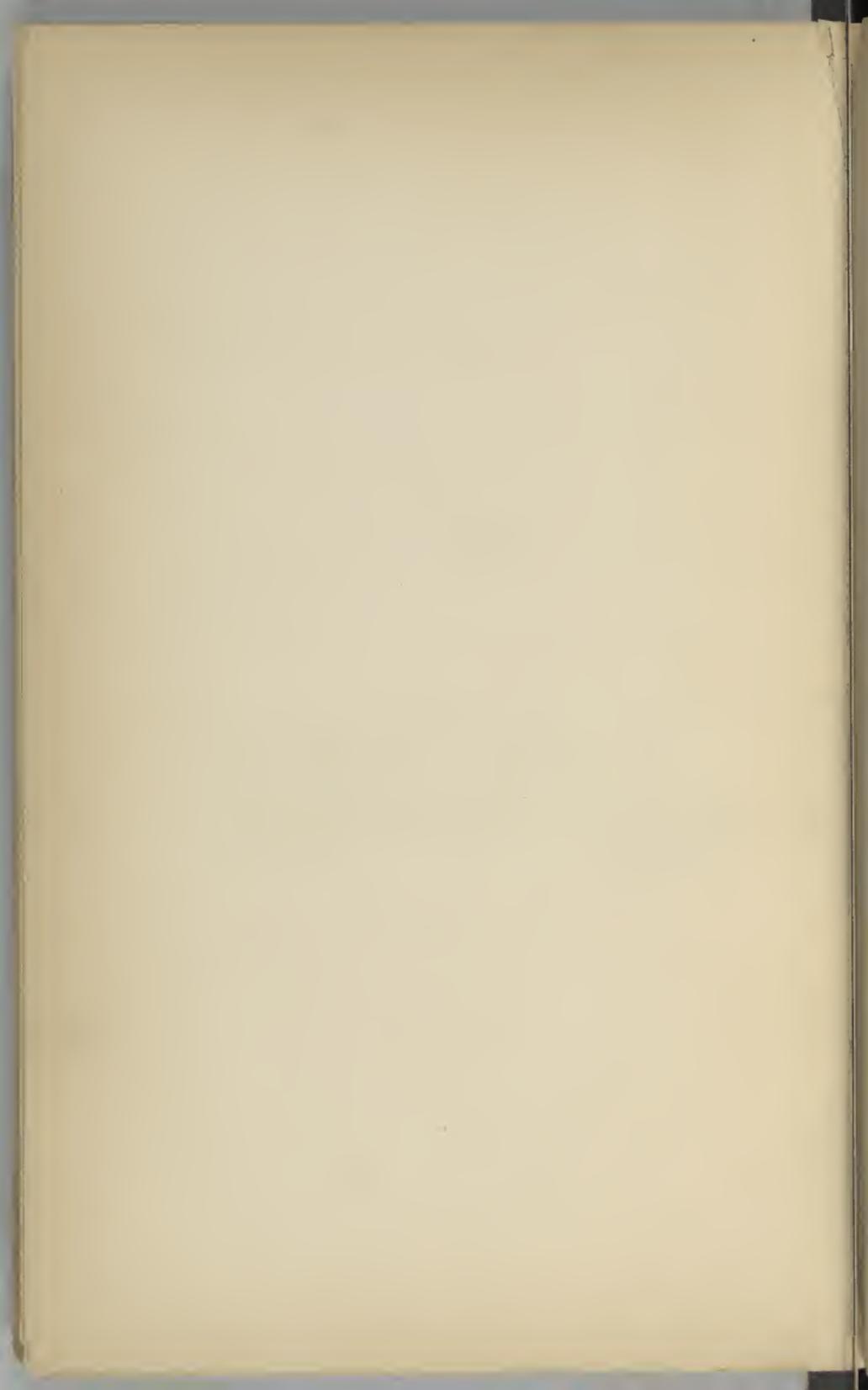
Focal

Plane.

1ST ORDER, 4 WICKS BURNER

4 $\frac{1}{2}$ inches





Chimney 11 1/4 inches.

Flame fully developed.

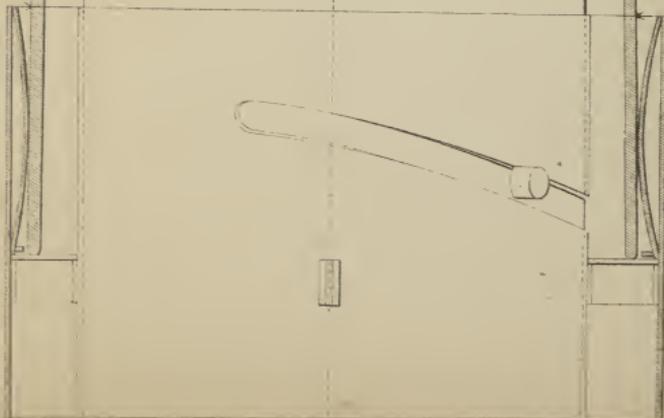
3 inches.

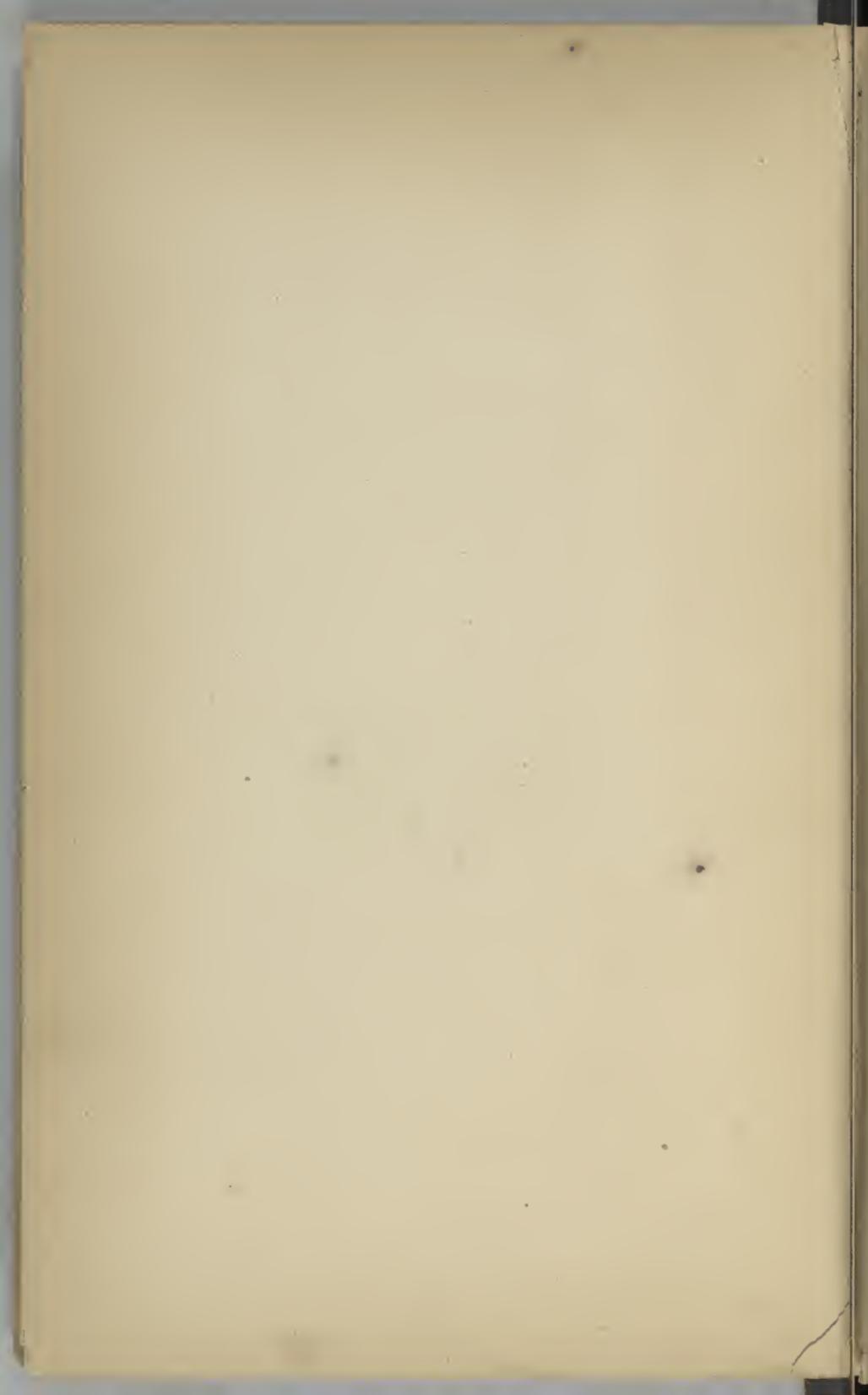
Focal

Plane

2ND ORDER, 3 WICKS BURNER

3 1/2 inches





Chimney 10 $\frac{3}{8}$ inches.

Flame fully developed.

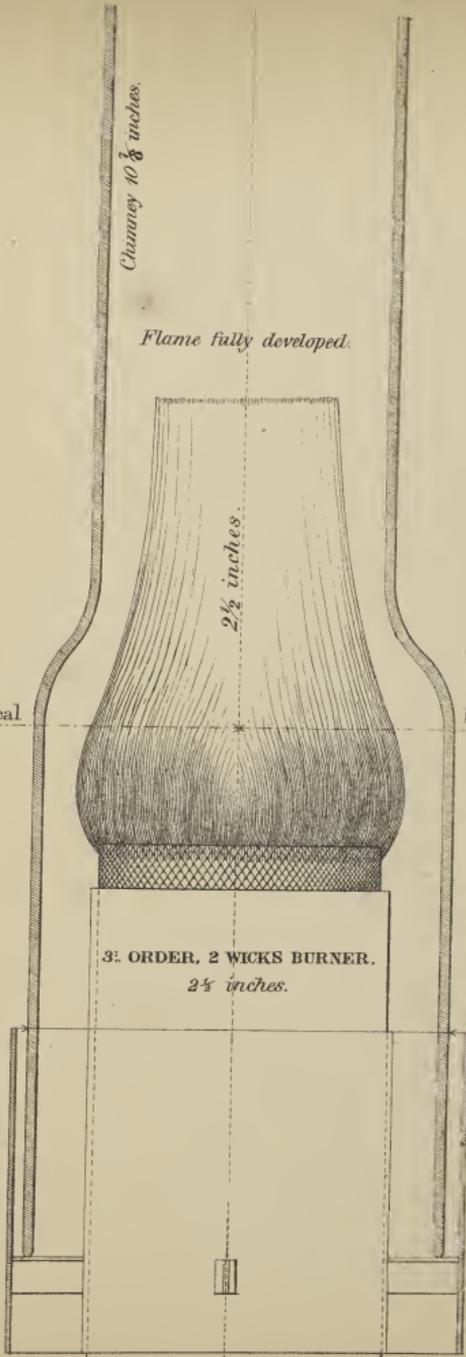
2 $\frac{1}{2}$ inches.

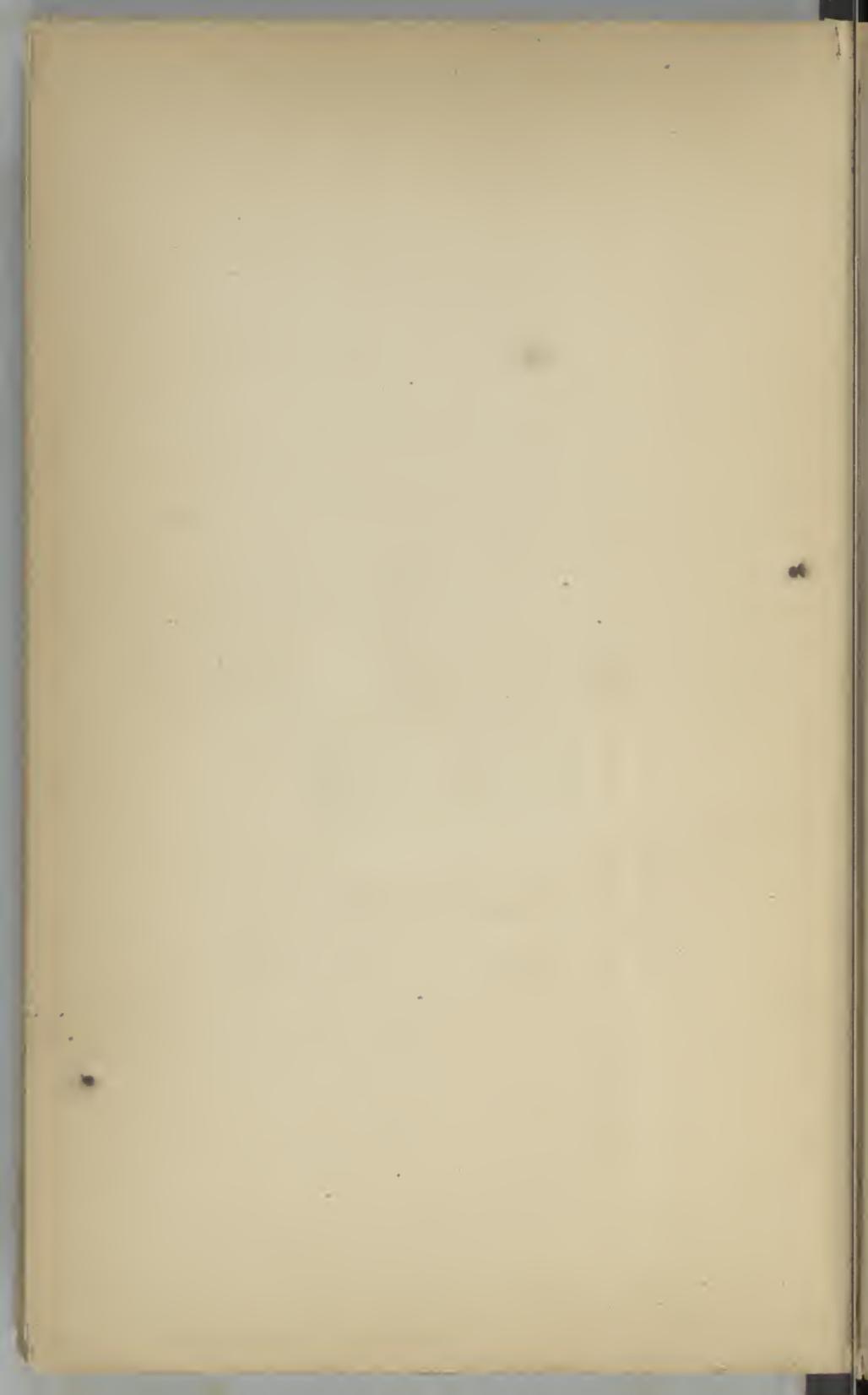
Focal

Plane

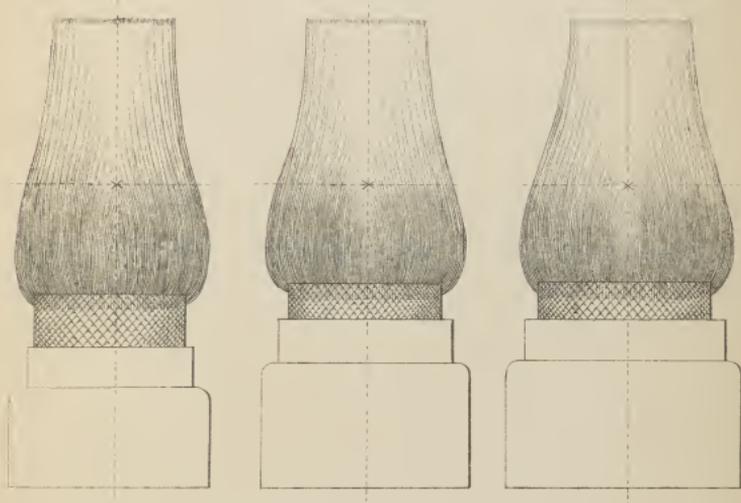
3^d ORDER, 2 WICKS BURNER.

2 $\frac{1}{4}$ inches.

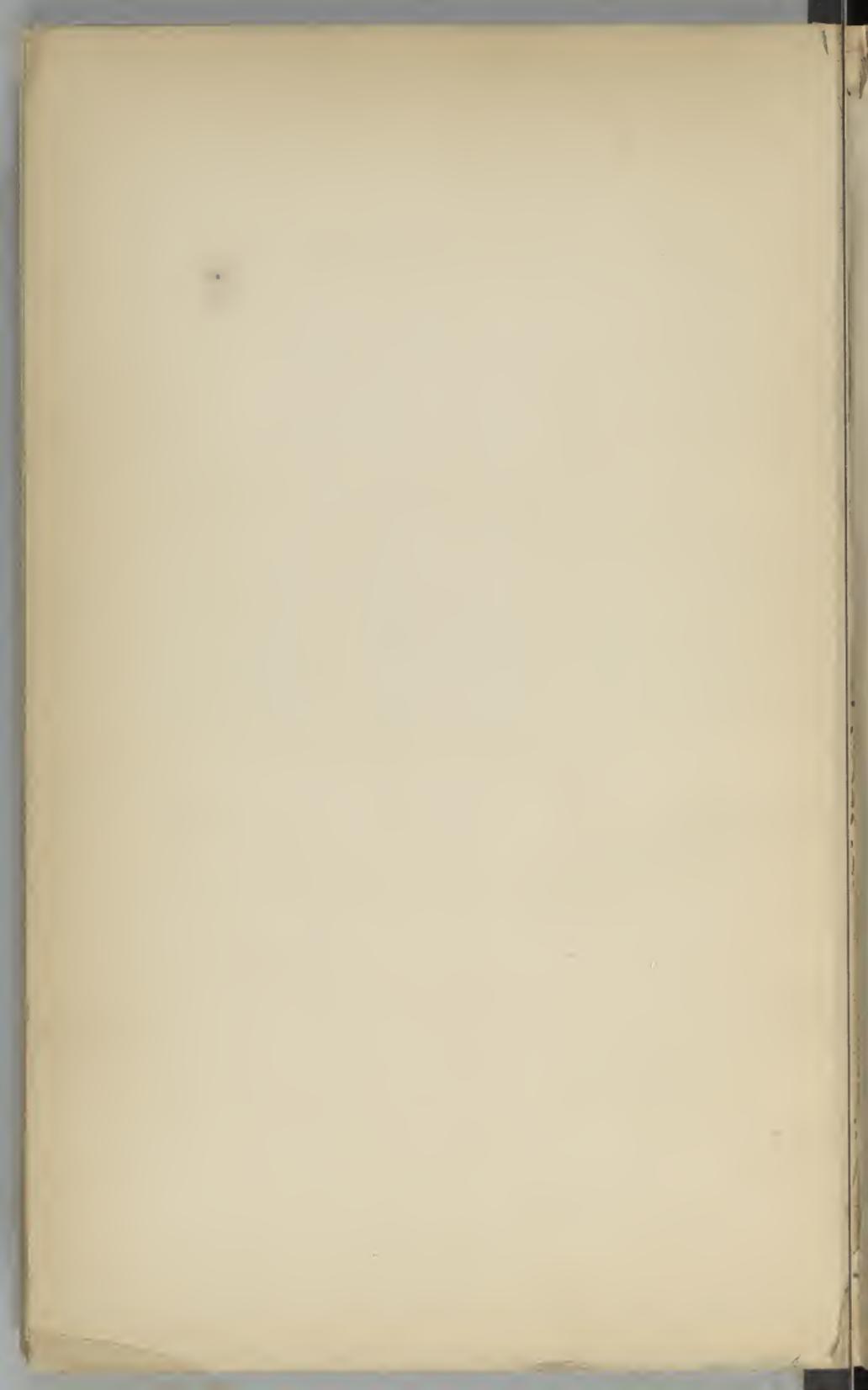




Flames of single wick burners.



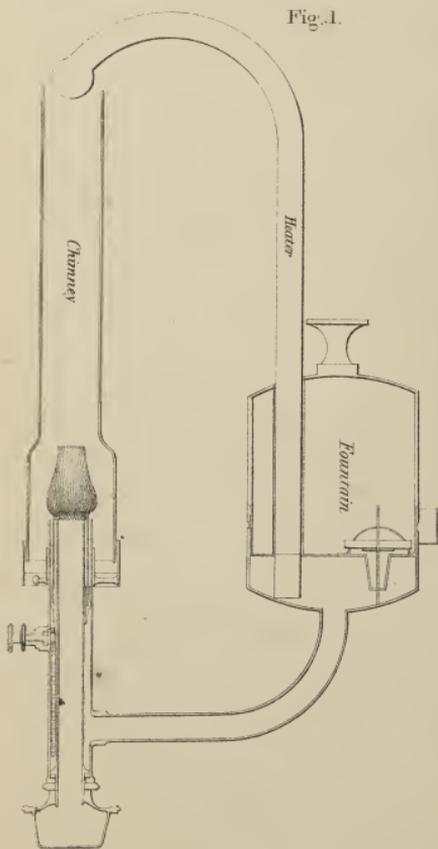
Chimney for 4th, 5th & 6th Order burners 11½ inches.

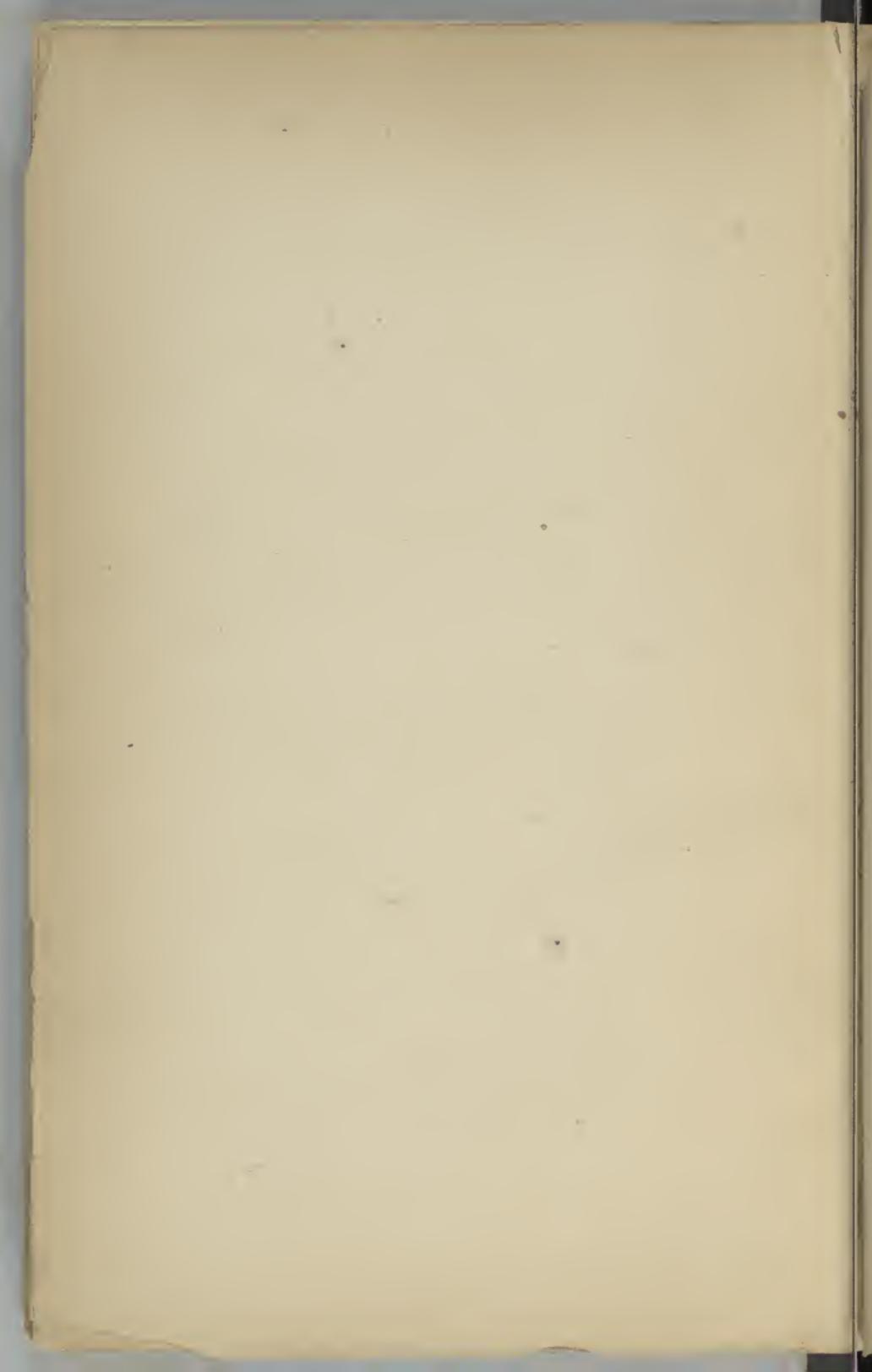


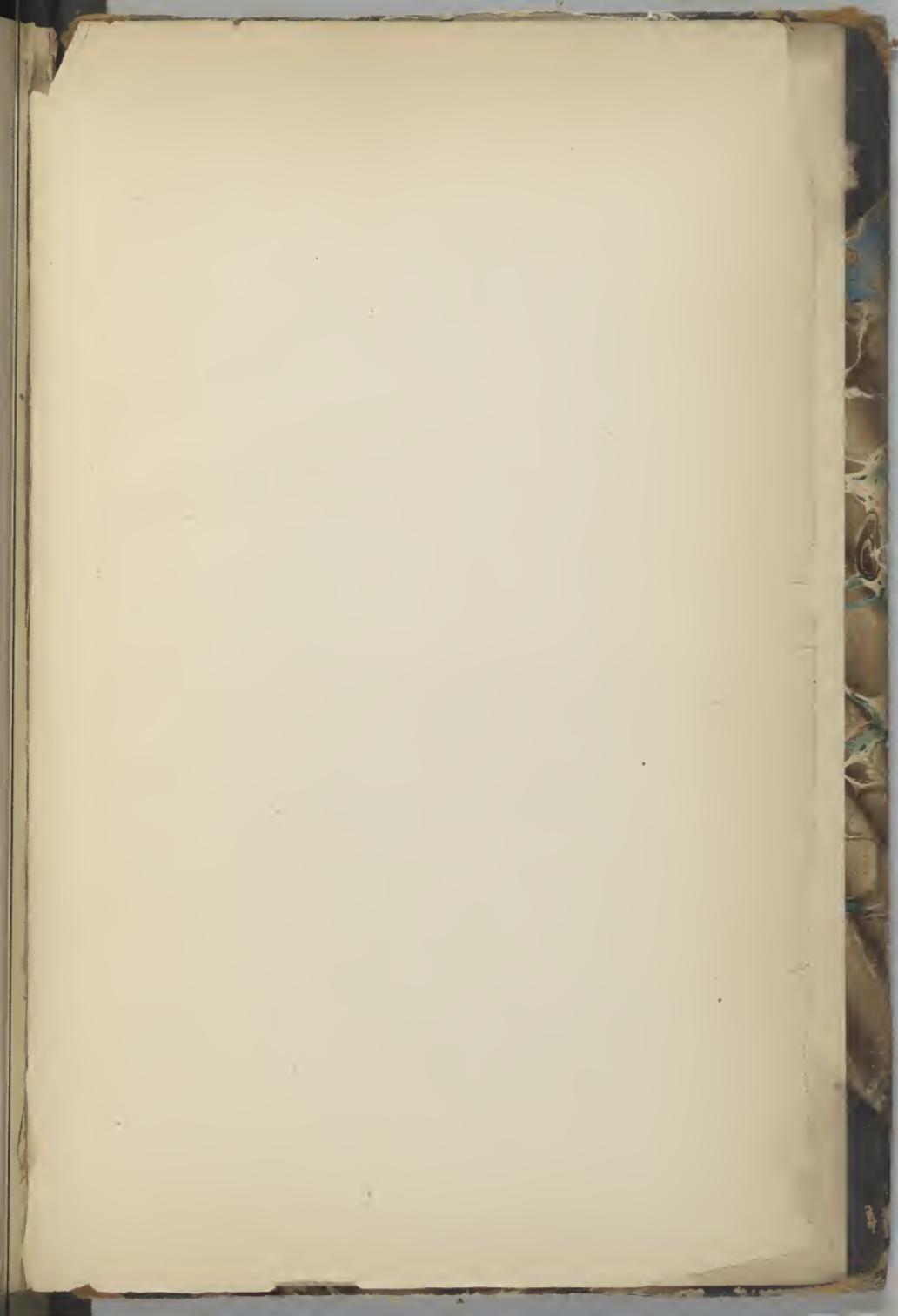
ARGAND FOUNTAIN LAMP
WITH RACK & PINION, BURNER & HEATER.

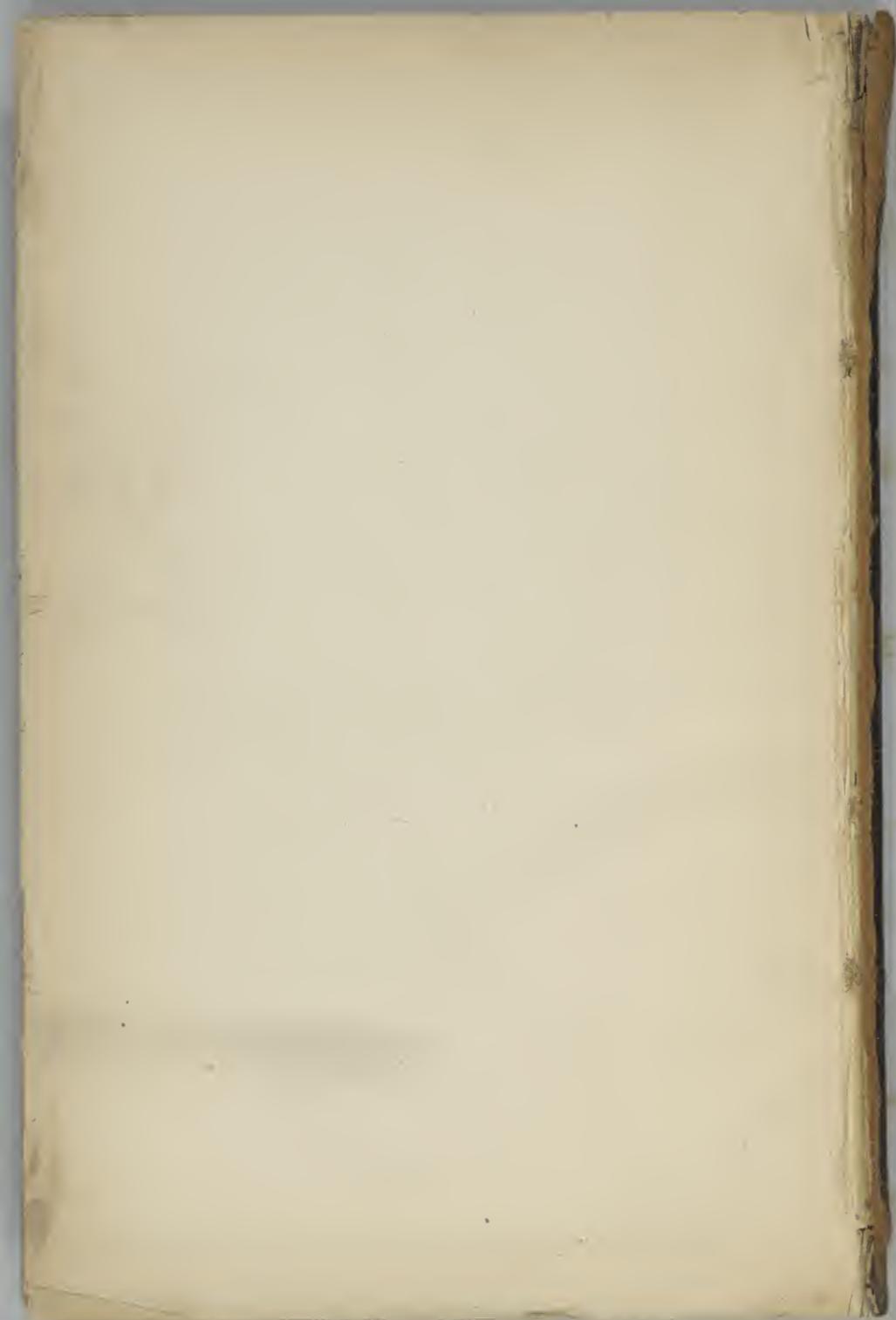
Scale $\frac{1}{4}$ size.

Fig. 1.









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NON



MICROFILMED

