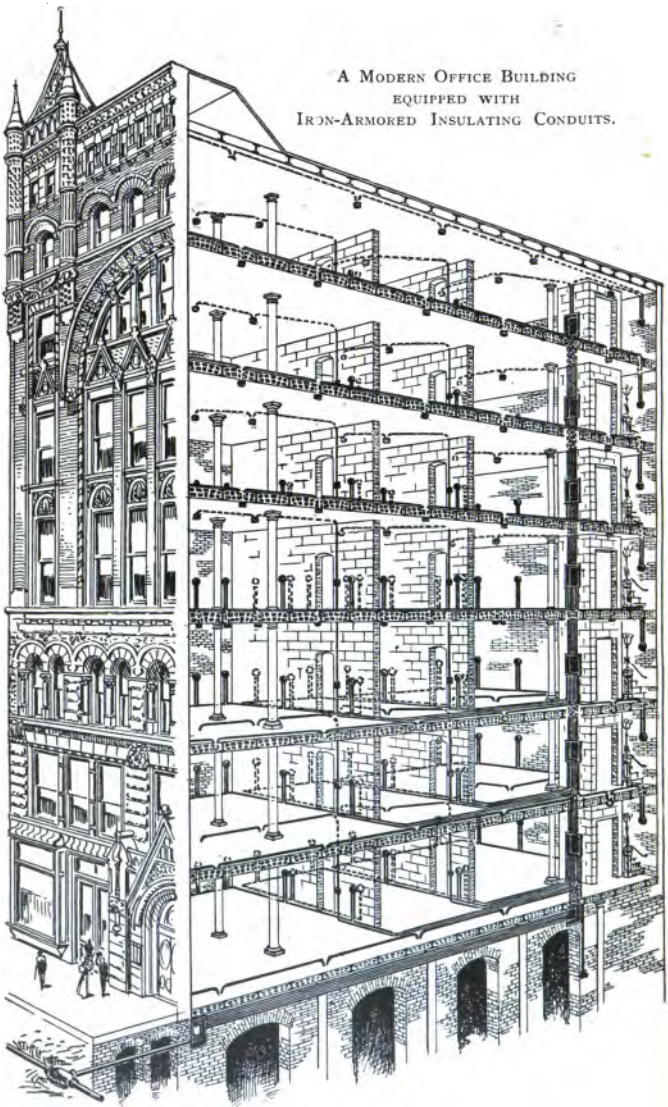

A Modern Office Building
equipped with
Iron-Armored Insulating Conduits.

ELECTRIC WIRING SPECIFICATIONS

FOR

INCANDESCENT LIGHTING

BY

GEORGE H. KIMBER

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PREFACE.

THE average architect in matters relating to Electric Lighting depends entirely upon the specifications handed in to him by the contractor. The true sense of confidence is frequently missing and the delays and subsequent difficulties encountered may frequently be traced to an unauthorized attempt on the part of the contractor to perform other than what is required of him, or a preconceived notion on the part of the architect that the extension of any small portion of the work is a matter of slight consequence to the contractor.

Aside from these embarrassing circumstances the frequency with which laxity is shown in the preparation of wiring specifications has led, in many cases to a misunderstanding of a permanent nature between both. It has been a constant source of worry to the architect because of the possibility that the specifications as accepted by him may be lacking in some detail far beyond his experience. It has been a means of reproach to the contractor as their unskilled preparation gives him room for the exercise of his powers of economy to a degree at times totally inconsistent with the attitude each bears to the other before the contract is signed.

To express the conditions required for the successful operation and installation of the wiring of a building in a manner explicit and intelligible to the untechnical mind would be a boon of immense value to the man whose conception is foreign and time well filled by attention to his own special vocation.

This is the age of specialists; none can equip themselves with

completeness in more than one branch of a profession or trade without a corresponding weakness in each respectively.

This book is a great labor saver in this respect. For Architects, Electrical Engineers, Contractors, Builders, etc., it will be a source of immediate information—a guide to the details of a complete wiring installation, and invaluable on account of its freedom from technical phrases.

The up-to-date methods with their attendant excellence will bring to the front the very highest grades of wiring. An architect may easily prepare his own specifications by this means with the unequaled satisfaction of knowing that the border lines have been drawn and the interior mapped out according to the best modern methods.

In very large buildings the assistance of an electrical expert will undoubtedly be required, but this modest volume will considerably lighten both his and the architect's labors, presenting itself to their notice as a guide in their travels through the mazes and complexities of modern wiring specifications.

GEO. H. KIMBER.

NEW YORK CITY.

CONTENTS.

Specifications for the Complete Electric Wiring to.....
Switch Outlets and.....Lamp Outlets for
.....16 Candle Power Incandescent Lamps or Their Equivalent in Lamps of Different Candle Power for.....

GENERAL CONDITIONS.

The whole intent of these specifications is to avoid lengthy details explanatory of requirements and standards clearly defined in headings enumerated. A complete installation of the highest standard is required. Contractor must recognize his liability and agree to furnish everything that may be required under these specifications, whether definitely referred to or only implied, and no extras whatever will be allowed except by written agreement.

Specifications and drawings.

This specification and the drawings are intended to co-operate, so that any work exhibited in the drawings and not mentioned in the specifications, or vice versa, is to be executed in the same manner as if mentioned in the specification or set forth in the drawing to the true meaning and intent of said drawings and specifications without any extra charge.

Co-operating with other contractors.

The contractor for this part of the work is to co-operate with the contractors for the other parts, so that, as a whole, the work shall be a finished and complete one of its kind, and is to arrange and carry on his work in such a manner that any of the co-operating contractors shall not be hindered or delayed at any time; and when his part of the work is finished, he shall remove from the premises all tools, machinery, etc., and, so far as he is concerned, leave the job clear from all obstructions or hindrances.

Defective work and materials.

If the contractor shall vary from the specifications in the form or quality in any work, or in the amount of value of the materials therein used, the architects or their agent shall be at liberty at any time, before or after the completion of the work, to order such improper work to be removed and replaced, and all works disturbed by the alteration made good at the contractor's expense.

Quality of work and materials.

The contractor will distinctly understand that the works described and shown are to be perfect and finished of their kind, and he is therefore enjoined to use all diligence to inform himself fully as to their construction and finish, and in no case to proceed with the different parts of the work without obtaining first, from the architects, such directions or drawings as may be necessary for the proper construction of the work.

Alterations, additions and omissions.

The architect shall be at liberty to order any alterations, additions or omissions of any kind, giving their order in writing; and the contract shall not be vitiated by any such act, but a fair addition or deduction is to be made in the payments to the contractor, according as such alterations increase or diminish the cost of the work.

Delay of work.

In case of an unusual or unnecessary delay or inability on the part of the contractor in providing and delivering the necessary materials and performing the necessary labor at the time the same is desired (whether the same is occasioned by strikes or otherwise), so as to secure the completion of the work at the time required, then and in such case, the architects within three days after having notified the contractor in writing of their intention to do so, shall have the right to enter upon the work, and procure such necessary materials and labor to be furnished or performed, as the case may require, and remove from the same all defective material or workmanship, as in their judgment may be found necessary, and carry on the work to completion in such way as shall be

proper and right, charging the cost of same to the contractor, and deducting such charges from the amount of the contract price.

Infringement of patents.

The contractor must guarantee the owner against all suits on account of infringements or alleged infringements of patents.

Work at contractor's risk.

It is to be understood by the contractor that the installation will be entirely at his risk until the same has been accepted, and he will be held liable for its safety to the amount of money paid him by the owners on account of the same.

Personal attention.

The personal and constant attention to the work by the contractor is hereby stipulated and guaranteed.

Responsibility for injuries.

The contractor shall be held responsible for any and all damages so occurring, and all damages due by injury of workmen, or persons in his employ, and engaged in or about the building.

Violation of ordinances.

The contractor must be responsible for any violation of city ordinances, underwriters' rules, or building laws on his part, and hold the owner harmless from any expense arriving from such violations.

Guarantee.

The contractor shall guarantee all the work done under this contract, as to material, labor and operation, for a period of one year from date of completion of this contract, and to furnish new material and to repair at his own cost and free of expense to the owner, any defects which may arise during said period.

Fire Underwriters' inspection.

All the work and all the material must be in strict accordance with the latest rules and regulations of the National Board of Fire Underwriters, and must meet with the approval of the Local Board of Fire Underwriters, before final payment for the work is made.

Scope of contract.

The building is to be wired complete by this contractor, including everything necessary to make a successful electric light wiring installation, such as wires, conduits, or moldings, cut-outs, cabinet cases, switches, etc.

CONDUITS.

Conduit system (iron or brass).

The contractor shall furnish and install a complete system of insulating conduits for the reception of all wires from the entrance of street service mains to each and every cabinet case, and from cabinet cases to all lamp and switch outlets, as marked on plans and described on distribution sheets attached.* All conduits shall be of sizes to meet requirements, so that no difficulty will be encountered in the drawing in of the wires. No conduit smaller than ⅜ inch inside diameter shall be used.

Conduits whether concealed or on the surface must be held in place by metal "clips" or straps, the use of nails for such purpose will not be allowed.

Fittings and appliances.

All fittings, elbows, couplings, etc., necessary for the complete installation must be those that are manufactured especially for such work.

Ends of conduits.

The ends of all conduits are to be cut off square and properly reamed with standard reamers.

Coupling conduits.

Before the couplings are crimped on to the brass conduit, the ends of conduit must be daubed with adhesive compound, and after the coupling is securely fastened, two layers of insulating tape must be wrapped on the joint.

Before placing the couplings on iron conduit, the threads must be thoroughly leaded, couplings must be screwed up tight, so that the ends of conduit will abut in centre.

Installing conduits.

Conduits must be first installed as a complete conduit system, without conductors, strings, or anything for the purpose of drawing in the conductor, and the conductors then to be pushed or fished in. The conductors must not be placed in position until all mechanical work on the building has been, as far as possible, completed.

* Architects are advised to make out detailed distribution sheets, similar to the one on page 38, showing all lamp and switch outlets.

Conduit at outlets.

All conduits at outlets must extend at least one inch beyond the finished surface of walls or ceilings, and all the ends must be closed with good adhesive insulating compound.

WIRES.

Classification of wires.

Wires shall be classed as feeders, risers, submains and branch circuit wires. The feeders being those which connect at the entrance of street service wires, and carry current to the various centres of distribution.

Feeders.

Risers.

The risers are the wires carrying the current from the centres of distribution to the cut-out cabinets.

Sub-mains.

The sub-mains are the wires carrying current from one cut-out cabinet to another, when the distance is too great to supply all outlets from one cabinet and obtain equal distribution.

Branch circuits.

The branch circuit wires are those carrying current from the cut-out cabinets to the various outlets.

Insulation and conductivity.

All wires must be of a high standard grade, rubber covered and have an approved braided covering, the copper to be of at least 96 per cent. conductivity, and the insulation of high resistance.

Limit of sizes.

No wires smaller than No. 14 B. & S. G. shall be used and all wires larger than No. 8, B. & S. G. shall be stranded.

Loop system.

All wires for the branch circuits must be continuous from outlet to outlet, and the loop system employed throughout. At each outlet the wires shall be neatly coiled and taped.

Approval of wire.

Before installing any wire the contractor shall submit to the architect, for his approval, a list showing the gauge of insulation to be used for each size of wire. The wires shall be not installed until approved in every particular by the Architect.

Joints.

There are to be no joints to be made in the wire.

LOSS IN POTENTIAL.

All wires are to be of such sizes that with all the lights in operation called for on distribution sheets, there will be no undue heating, and the loss of potential between entrance of street service mains and any outlet will not be greater than 5 per cent., and the variation between any two outlets in the building will not be greater than 2 per cent.

SYSTEM OF WIRING.

In selecting the system of wiring and conduits for a building, it must first be determined at what voltage the current will enter the building; if alternating or direct current will be used, and whether the system of wiring will be two or three wires. (This information can be obtained from the local lighting company.) On the following pages the principal systems of wiring and conduits are described under separate schedules so that a proper selection can be made, but to aid in the selection of a system for the different requirements, the schedules are tabulated according to their grades as follows:

System.	First Grade.	Second Grade.	Third Grade.	Fourth Grade.	Fifth Grade.
For 3 wire system, direct current. use schedule	A	C	E	G	H
For 2 wire system, direct current, use schedule	B	D	F	G	H
Fhr 2 wire system, alternating current, ues schedule	B	D	F	G	H

SCHEDULE "A."

General Method of Wiring and System of Conduits for Three Wire System, 230-115 Volts for Direct Current in Iron Armored Conduits.

The building is to be wired on the three and two wire system from the entrance of street service mains on....floor near to point marked on plans to each and every lamp and switch outlet as described on distribution sheets attached.

Feeders, risers, and sub-mains.

All feeders, risers and submains shall have three wires each, and must be so calculated that the middle or neutral wire will have a carrying capacity equal to the sum of the two outside wires.

System of feeders.

From the point of entrance of the street service mains the following feeders shall be run:

One set of feeders for all lights in basement except those coming under the heading of public lighting.

One set of feeders for all public lighting which includes the halls, lavatories, store-room, elevator, stair-cases and entrances.

One or more sets of feeders to the different floors, these feeders to be calculated so as to provide for equal distribution of light.

All feeders, risers and submains shall pass through or terminate in suitable cabinet cases, as hereinafter described.

Branch circuits.

All branch circuits shall be run from these cabinet cases. Not more than 7½ amperes of current to be used on any branch circuit.

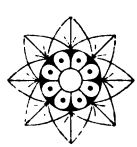
Capacity of lamps.

The sixteen candle power lamps are to be figured on the basis of 110 volts: one-half ampere lamp capacity, and the calculation is to be made on the two wire system.

Iron conduits.

All conduits and their appliances shall be iron armored of approved manufacture.

For all feeders, risers and sub-mains there shall be provided a separate conduit for each wire, and for all branch circuits two wires are to be run in a single conduit.



SCHEDULE "B."

General Method of Wiring and System of Conduits for Two Wire System, 115, 104 and 52 Volts, for Direct or Alternating Currents in Iron Armored Conduits.

The building is to be wired on the two-wire system, from the entrance of street service mains on .....floor, near to point marked on plan, to each and every lamp and switch outlet as described on distribution sheets attached.

System of feeders.

From the entrance of street service mains, the following feeders shall be run:

One set of feeders for all lights in basement except those coming under the heading of public lighting.

One set of feeders for all public lighting, which includes the halls, lavatories, store-room, elevator, staircases and entrances.

One or more sets of feeders to the different floors; these feeders to be calculated so as to provide for equal distribution of light.

All feeders, risers and sub-mains shall pass through or terminate in suitable cabinet cases, as hereinafter described.

Branch circuits.

All branch circuits shall be run from these cabinet cases.

Capacity of lamps.

The sixteen candle power lamps are to be figured on the basis of 110 volts, one-half ampere lamp capacity; and lamps of lower voltage to be figured proportionately.*

Iron conduits.

All conduits and their appliances shall be iron armored of approved manufacture.

The single tube system shall be used throughout; that is, two wires in a single conduit for all wires carrying not more than 100 amperes of current. In case more than 100 amperes are required, additional circuits must be provided.

* If fifty volt lamps are used, one ampere of current must be estimated for each lamp.

SCHEDULE "C."

General Method of Wiring and System of Conduits for Three Wire System, 230 and 115 Volts, for Direct Currents in a Combination System of Conduits.

The building is to be wired on the three and two wire system from the entrance of street service mains on.....floor, near to point marked on plans, to each and every lamp and switch outlet, as described on distribution sheets attached.

Feeders, risers and sub-mains.

All feeders, risers and sub-mains shall have three wires each, and must be so calculated that the middle or neutral wire will have a carrying capacity equal to the sum of the two outside wires.

System of feeders.

From the point of entrance of the street service mains the following feeders shall be run:

One set of feeders for all lights in basement except those coming under the heading of public lighting.

One set of feeders for all public lighting, which includes the halls, lavatories, store-room, elevator, staircases and entrances.

One or more sets of feeders to the different floors, these feeders to be calculated so as to provide for equal distribution of light.

All feeders, risers and sub-mains shall pass through or terminate, in suitable cabinet cases, as hereinafter described.

Branch circuits.

All branch circuits shall be run from these cabinet cases. Not more than 7½ amperes of current to be used on any branch circuit.

Capacity of lamps.

The sixteen candle power lamps are to be figured on the basis of 110 volts, one-half ampere lamp capacity, and the calculation is to be made on the two wire system.

Brass conduits.

All feeders and risers shall be installed in brass armored insulating conduits, and a separate tube must be provided for each wire.

Iron conduits.

All sub-mains and branch circuit wires must be run in iron armored insulating conduits; for sub-mains a separate conduit must be provided for each wire, and for branch circuits two wires are to be run in a single conduit.

SCHEDULE "D."

General Method of Wiring and System of Conduits for Two Wire System, 115, 104 and 52 Volts, for Direct or Alternating Currents in a Combination System of Conduits.

The building is to be wired on the two wire system from the entrance of street service mains on..... floor, near to point marked on plan, to each and every lamp and switch outlet as described on distribution sheets attached.

System of feeders.

From the point of entrance of street service mains the following feeders shall be run:

One set of feeders for all lights in basement except those coming under the heading of public lighting.

One set of feeders for all public lighting, which includes the halls, lavatories, store-room, elevator, staircases and entrances.

One or more sets of feeders to the different floors, these feeders to be calculated so as to provide for equal distribution of light.

All feeders, risers and sub-mains shall pass through or terminate in suitable cabinet cases, as hereinafter described.

Branch circuits.

All branch circuits shall be run from these cabinet cases.

Capacity of lamps.

The sixteen candle power lamps are to be figured on the basis of 110 volts, one-half ampere lamp capacity, and lamps of lower voltage are to be figured proportionately.*

Brass conduits.

All feeders and risers shall be installed in brass armored insulating conduits, and a separate tube must be provided for each wire.

Iron conduits.

All sub-mains and branch circuit wires must be run in iron armored insulating conduits, two wires in a single tube.

* If fifty volt lamps are used, one ampere of current must be estimated for each lamp.

SCHEDULE "E."

General Method of Wiring and System of Conduits for Three Wire System, 230–115 Volts, for Direct Currents in Brass Armored Conduits.

The building is to be wired on three and two wire system from the entrance of street service mains on .....floor near to point marked on plans to each and every lamp and switch outlet as described on distribution sheets attached.

Feeders, risers and sub-mains.

All feeders, risers and sub-mains shall have three wires each, and must be so calculated that the middle or neutral wire will have a carrying capacity equal to the sum of the two outside wires.

System of feeders.

From the point of entrance of street service mains the following feeders shall be run:

One set of feeders for all lights in basement except those coming under the heading of public lighting.

One set of feeders for all public lighting which includes the halls, lavatories, store-room, elevator, staircases and entrances.

One or more sets of feeders to the different floors, these feeders to be calculated so as to provide for equal distribution of light.

All feeders, risers, and sub-mains shall pass through or terminate in suitable cabinet cases, as hereinafter described.

Branch circuits

All branch circuits shall be run from these cabinet cases. Not more than 7½ amperes of current to be used on any branch current.

Capacity of lamps

The sixteen-candle power lamps are to be figured on the basis of 110 volts; one-half ampere lamp capacity, and the calculation is to be made on the two wire system.

Brass conduit.

All conduits and their appliances shall be brass armored of approved manufacture.

For all wires a separate conduit must be provided for each wire.

SCHEDULE "F.'

General Method of Wiring and System of Conduits for Two Wire System, 115, 104 and 52 Volts, for Direct or Alternating Currents, in Brass Armored Conduits.

The building is to be wired on the two wire system from the entrance of street service mains on.....floor near to point marked on plans, to each and every lamp and switch outlet, as described on distribution sheets attached.

System of feeders.

From the point of entrance of the street service mains the following feeders shall be run:

One set of feeders for all lights in basement except those coming under the heading of public lighting.

One set of feeders for all public lighting, which includes the halls, lavatories, store-room, elevator, staircases and entrances.

One or more sets of feeders to the different floors; these feeders to be calculated so as to provide for equal distribution of light.

All feeders, risers and sub-mains shall pass through or terminate in suitable cabinet cases, as hereinafter described.

Branch circuits.

All branch circuits shall be run from these cabinet cases. Not more than 7½ amperes of current to be used on any branch circuit.

Capacity of lamps.

The sixteen candle power lamps are to be figured on the basis of 110 volts; one-half ampere lamp capacity, and lamps of lower voltage to be figured proportionately.*

Brass conduits.

All conduits and their appliances shall be brass armored of approved manufacture.

For all wires a separate conduit must be provided for each wire.

* If 50 volt lamps are used, one ampere of current must be estimated for each lamp.

SCHEDULE "G."

General Method of Wiring for Direct or Alternating Currents Three or Two Wire System 230, 115, 104 and 52 Volts, in Wood Molding and Brass Conduits and Wood Molding and Iron Conduits.

The building is to be wired on the.....(three or two) wire system from the entrance of street service mains on.....floor, near to a point marked on plans to each and every lamp and switch outlet as detailed on distribution sheets attached.

(NOTE: Insert if three wire system is to be used:

Feeders, risers and sub-mains.

All feeders, risers and sub-mains shall have three wires each, and must be so calculated that the middle or neutral wire will have a carrying capacity equal to the sum of the two outside wires.)

System of feeders.

From the point of entrance of the street service mains the following feeders shall be run :

One set of feeders for all lights in basement except those coming under the heading of public lighting.

One set of feeders for all public lighting which includes the halls, lavatories, store-room, elevator, stair-cases and entrances.

One or more sets of feeders to the different floors, these feeders to be calculated so as to provide for equal distribution of light.

All feeders, risers and sub mains shall pass through or terminate in suitable cabinet cases, as hereinafter described.

Branch circuits.

All branch circuits shall be run from these cabinet cases.

Capacity of lamps.

The sixteen candle power lamps are to be figured on the basis of 110 volts; one-half ampere lamp capacity, and lamps of lower voltage to be figured proportionately.

Wood moldings.

Wooden moldings must be furnished for all exposed work. All moldings must consist of two pieces, a backing and capping so constructed and grooved as to thoroughly incase the wires and maintain a distance of not less than one-half inch between conductors. They must be filled and receive two coats of water-proof paint. Moldings must not be used in concealed work and damp places.

NOTE: For alternating or direct currents, three or two wire system. Branch circuits in Brass Conduits, insert:

Brass conduits.

For all branch circuits from cabinet cases, and for all wires passing through walls, partitions, floors, timbers, etc., brass armored insulating conduits must be used, a separate tube must be provided for each wire. Not more than 7½ amperes of current to be used on any branch circuit.

NOTE: For direct current, three-wire system, Branch circuits in Iron Conduits, insert:

For all branch circuits from cabinet cases, and for wires passing through walls, partitions, floors, timbers, etc. Iron-armored Insulating Conduits must be used on the single tube system, that is, two wires in a tube. Not more than 7½ amperes of current to be used on any circuit.

NOTE: For Alternating and Direct currents, two wire system, Branch circuits in Iron Conduits, insert:

For all branch circuits from cabinet cases and for all wires passing through walls, partitions, floors, timbers, etc. Iron-armored Insulating Conduits must be used on the single tube system, that is, two wires in a tube.

Alternate proposal.

Alternate proposals may be invited, using porcelain cleats or knobs for open work in the place of wood moulding, if so desired insert: All wires must be kept 2½ inches apart.

SCHEDULE "H."

General Method of Wiring Three and Two Wire System for Direct and Alternating Currents, 230, 115, 104 and 52 Volts, Cleat Work.

The building is to be wired on the - (three or two wire) system from the entrance of street service mains on....floor near to a point marked on plans to each and every lamp and switch outlet detailed on distribution sheets attacked.

(NOTE: Insert if three wire system if to be used: All feeders, risers, and sub-mains shall have three wires each, and must be so calculated that the middle or neutral wire will have a carrying capacity equal to the size of the two outside wires)

System of feeders.

From the point of entrance of street service mains the following feeders shall be run:

One set of feeders for all lights in basement except those coming under the heading of public lighting.

One set of feeders for all public lighting which includes halls, lavatories, store-rooms, elevator, staircases and entrances.

One or more sets of feeders to the different floors these feeders to be calculated so as so provide for equal distribution of light.

All feeders, risers and sub-mains shall pass through or terminate in suitable cabinet cases or cut-out boxes.

Branch circuits.

All branch circuits shall be run from these cabinet cases or cut-out boxes.

Capacity of lamps.

The 16 candle power lamps are to be figured on the basis of 110 volts, one-half ampere capacity, and lamps of lower voltage to be figured proportionately.

Supporting wires.

All wires must be supported on non-combustible porcelain cleats, constructed so as to prevent the insulating coverings of the wire from coming in contact with other substances than the insulating sup ports.

For all circuits of 115 volts or less the wires must be kept 2½ inches apart.

Pendant lights from porcelain cut-outs.

The Contractor shall install.....double pole porcelain pendant cut-outs or rosettes. These cut-outs snall be wired with flexible cord for pendant lighting and the sockets attached thereto. Each pendant cord to be.....feet in length and must be knotted at both ends, so that the weight will not come on the binding screws of the sockets or cuts-out.

CABINET CASES.

Cabinet cases and panel boards.

The Contractor shall provide and place at con. venient centres of distribution suitable cabinet cases, containing panel boards. All branch circuits shall emanate from these cabinet cases.

The cabinet cases shall be made of hard wood not less than ¾ inch in thickness and must be lined throughout on the inside with slate not less than one-quarter of an inch thick.

Each cabinet case must be provided with an outer frame and door of neat design finished to correspond with interior trim of building. The doors must be mounted on hinges and each case provided with a lock and key. Where more than one cabinet case is used, one master key must be provided for them all.

In these cases, there must be placed a panel of marblized slate, not less than ¾ inch in thickness, upon which must be mounted the necessary bus bars, terminals for feeders, terminals for branch circuits and connections for fuses. All brass work must be highly polished.

CUT-OUTS.

Street service.

A (double or triple) pole cut-out of a capacity to carry the total amount of current entering building must be placed at the entrance of street service mains.

Branch cut-outs.

Cut-outs must be placed at every point where a change is made in the size of the wire, (unless the cut-out in the larger wire will protect the smaller).

All cut-outs must be supported on bases of non-combustible, insulating, moisture proof material, and must be stamped with their maximum safe carrying capacity in amperes. They must be so constructed that an arc cannot be maintained across its terminals by the fusing of the metal.

Combination fixtures.

For combination (gas and electric) fixture work no group of lamps requiring a current of six amperes or more shall be ultimately dependent upon one cut-out.

SAFETY FUSES.

All safety fuses must be of the latest type and have copper tips. They must have their ampere carrying capacity plainly marked thereon, and have at least 25 per cent. carrying capacity in excess of the current required on circuits which they control.

All fuses must be so proportioned to the conductors they are intended to protect that they will melt before maximum safe carrying capacity of the wire is exceeded.

It must be clearly understood that the size of the fuse depends upon the size of the smallest conductor it protects, and not upon the amount of current to be used in the circuit.*

The Contractor must supply a duplicate set of new fuses for all cut-outs.

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* See table of safe-carrying capacity of wires, page 49.

SWITCHES.

Switch for service mains.

At the entrance of street service main to building the contractor shall provide and place in position a (double or triple pole) switch of approved make, and of ample capacity to carry the total amount of current entering building.

All switches must be mounted on moisture proof and non-combustible bases. They must have a firm and secure contact, must make and break readily and not stop when motion has been imparted by the handle.

Double-pole switches

Switches marked on plans and distribution sheets must be located at convenient points. They must be double pole. Where flush switches are desired they must be placed flush with finish of wall and covered with a polished metal plate to correspond to finish of surrounding hardware. No switch of less than 10 amperes carrying capacity must be used.

Flush switches.

All switches of the flush type must be placed in (iron or brass) insulated boxes.

ELEVATOR CABLE.

The contractor must provide an outlet at the middle of elevator shaft and also the necessary attachments to connect to the elevator cage. The cable carrying current must be well insulated, flexible and protected to withstand abrasion.

The elevator cage must be wired for.....sixteen candle power lamps.

METER BOARD AND METER.

The contractor shall furnish and place in position .....meter boards or brackets to be located at points to be agreed upon. They must be of a neat design

and of a size suitable to receive the meters which will be provided and placed in position by another party.

LAMPS.

All lamps required under these specifications will be furnished by another contractor.

SOCKETS AND RECEPTACLES.

The Contractor shall provide.....key sockets, ...keyless sockets, ...floor receptacles, and .....wall socket receptacles of approved make. All sockets shall be finished to correspond to finish of fixtures.

FIXTURES AND WIRING.

Shade holders, insulating joints and cut-outs.

All fixtures, and wiring of same, shades and shade-holders will be provided under another contract, but the contractor for the wiring must place them in position and furnish the necessary insulating joints and cut-outs of approved type.

Condensation.

The tendency to condensation within the pipes must be guarded against by sealing the upper end of the fixture.

Cut-outs.

The use of "bugs" or any form of cut-out in the canopies of fixtures must be avoided as far as possible; the fuse for electroliers, wall brackets, etc., should be located in cabinet cases.

WATER-PROOF SOCKETS.

For lights placed out-doors, the contractor shall provide water-proof sockets and moisture-proof globes for all lamps.

TRANSFORMERS.

Tha transformers will be furnished and placed in position under another contractor.*

FIXTURE SUPPORTS.

At all outlets where there are no gas pipes contractor is to furnish and put in place suitable fixture supports.

Cutting of brick work.

All cutting of channels for the reception of the conduits and wires will be done under another contract.†

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* Omit transformers if direct current is to be used.

† Architects are urged, when drawing plans, to make provisions for the channelling and pocketing of buildings for the reception of all conduits and their appliances.

ADDENDA.

The following clauses may be inserted in the specifications if so desired:

DECORATIVE LIGHTING.

Decorative lighting is sometimes required in dining-rooms, reception-rooms, etc., for special occasions. The architects should, therefore, provide suitable outlets and fittings at convenient points to admit of such lighting. Floor receptables for table decorative lighting and other purposes should be specified if required.

DESK LIGHTS AND RECEPTACLES FOR ATTACHING FAN MOTORS.

Wherever desk lights are required from side-outlets they should be clearly located and specified. Receptacles should also be provided for making connections for fan motors, if required in offices and other rooms.

DUPLICATE CIRCUITS.

Sometimes it is desirable to run the circuits in such a manner that rooms shall not be dependent upon one circuit and its fuses; if so desired, insert the following:

Every alternate outlet (or every alternate light)

in rooms numbered..... on plans, shall be wired so that every alternate outlet (or lamp) is grouped on an independent circuit from the cabinet case.

CEILING, SIDE AND SWITCH OUTLET BOXES.

If outlet boxes for the reception of cut-outs, etc., are required for ceiling and side outlets, insert

Ceiling outlet boxes. Standard insulated boxes must be used at every ceiling and side lamp outlet. Where ceiling boxes are used they must be provided with a suitable chandelier support; this support, consisting of a gas pipe, running through ceiling to floor above and passing through an iron spreader so that the weight of the chandelier will be evenly distributed.

Side outlet boxes. Where side outlet boxes are used conduits must be securely threaded, crimped or cemented in same.

Outlet boxes. All outlet boxes must be of a neat design and of such sizes that the ordinary canopy furnished with chandeliers will cover them. They must also be designed to carry double pole cut-outs and insulating joints.

Switch boxes. Switch boxes must be thoroughly insulated and conduits firmly secured thereto.

HALL LIGHTS.

For residence lighting, it is often desirable to have the hall lights controlled from two different points If so required, insert

Controlling lights from two points. The hall lights (and other lights so designated) shall be wired and controlled by three way switches, so that the lights in the halls above or below may be operated from any floor.

BOXES FOR CEILING LIGHTS.

The contractor shall install.....(brass or iron) insulating boxes and covers fitted with receptacles for incandescent lamps.

All boxes shall be such as are especially adapted for connecting to the conduit system.

BOXES FOR PENDANT LIGHTS.

Receptacles.

There shall be provided.....(brass or iron) insulating boxes and covers. These covers to be tapped in centre to receive a (¼ or ⅜ inch) gas pipe .....inches in length. The contractor shall also furnish, connect, and wire sockets of approved type to these fixtures.

The contractor shall furnish.....(brass or iron) insulating boxes and covers. These covers shall be drilled in the centre and the holes bushed with hard rubber. Sockets of approved type must be furnished and connected by flexible cord.....feet each in length to the boxes. The flexible cords shall be knotted at both ends so that the weight will not come on the binding screws of sockets or cut-outs.

SCHEDULE FOR DISTRIBUTION.

LOCATION.	1 LIGHT.		2 LIGHTS.		....LIGHTS.		....LIGHTS.		....LIGHTS.		SWITCHES.	TOTAL LAMPS.
	Ceiling.	Side.	Ceiling	Side.	Ceiling.	Side.	Ceiling.	Side.	Ceiling.	Side.		

EXTRACTS

FROM THE

RULES AND REQUIREMENTS

OF THE

National Board of Fire Underwriters,

FOR THE INSTALLATION OF

WIRING AND APPARATUS

FOR

ELECTRIC LIGHT, HEAT AND POWER

AS RECOMMENDED BY THE

UNDERWRITERS' NATIONAL ELECTRIC ASSOCATION.

January 1, 1896.

GENERAL SUGGESTIONS.

In all electric work, conductors, however well insulated, should always be treated as bare, to the end that under no conditions, existing or likely to exist, can a grounding or short circuit occur, and so that all leakage from conductor to conductor, or between conductor and ground, may be reduced to the minimum.

In all wiring special attention must be paid to the mechanical execution of the work. Careful and neat running, connecting, soldering, taping of conductors, and securing and attaching of fittings, are specially conducive to security and efficiency, and will be strongly insisted on.

In laying out an installation the work should, if possible, be started from a center of distribution, and the switches and cut-outs, controlling and connected with the several branches, be grouped together in a safe and easily accessible place, where they can be readily got at for attention or repairs. The load should be divided as evenly as possible among the branches and all complicated and unnecessary wiring avoided.

The use of wire-ways for rendering concealed wiring permanently accessible is most heartily endorsed and recommended; and this method of accessible concealed construction is advised for general use.

Architects are urged, when drawing plans and specifications, to make provision for the channeling and pocketing of buildings for electric light or power wires, and in specifications for electric gas lighting to require a two-wire circuit, whether the building is to be wired for electric lighting or not, so that no part of the gas fixtures or gas piping be allowed to be used for the gas-lighting circuit.

Class C.

LOW-POTENTIAL SYSTEMS.

300 VOLTS OR LESS.

OUTSIDE CONDUCTORS.

15. OUTSIDE OVERHEAD CONDUCTORS:

a. Must be erected in accordance with the rules for high-potential conductors.

b. Must be separated not less than 12 inches, and be provided with an *approved* fusible cut-out, that will cut off the entire current as near as possible to the entrance to the building, and inside the walls.

An *approved* fusible cut-out must comply with the sections of Rules 23 and 24 describing fuses and cut-outs. The cut-out required by this section must be placed so as to protect the switch required by Rule 17.

16. UNDERGROUND CONDUCTORS:

a. Must be protected, when brought into a building, against moisture and mechanical injury, and all combustible material must be kept removed from the immediate vicinity.

b. Must have a switch and a cut-out for each wire between the underground conductors and the interior wiring when the two parts of the wiring are connected.

These switches and fuses must be placed as near as possible to the end of the underground conduit, and connected therewith by specially insulated conductors, kept apart not less than two and one-half inches.

The cut-out required by this section must be placed so as to protect the switch.

c. Must not be so arranged as to shunt the current through a building around any catch-box.

INSIDE WIRING—GENERAL RULES.

17. At the entrance of every building there shall be an *approved* switch placed in the service conductors by which the current may be entirely cut off.

The switch required by this rule to be *approved* must be of such construction that each wire entering the building will be disconnected when the switch is open, must plainly indicate whether the current is "on" or "off," and must comply with Sections *a*, *c*, *d* and *e* of Rule 26 relating to switches.

18. CONDUCTORS:

a. Must have an *approved* insulating covering, and must not be of sizes smaller than No. 14 B & S., No. 16 B. W. G. or No. 4 E. S. G., except as allowed under Rule 27 (*d*) and 31 (*a*).

In so-called "concealed" wiring, moulding and conduit work, *and* in places liable to be exposed to dampness, the insulating covering of the wire to be *approved*, must be solid, at least $\frac{3}{64}$ of an inch in thickness, and covered with a substantial braid. It must not readily carry fire, must show an insulating resistance of one megohm per mile after two weeks' submersion in water at 70 degrees Fahrenheit, and three days' submersion in lime water, with a current of 550 volts and after three minutes' electrification.

(See List of Wires, page 49.)

For work which is *entirely* exposed to view throughout the whole interior circuits, and not liable to be exposed to dampness, a wire with an insulating covering that will not support combustion, will resist abrasion, is at least 1-16 of an inch in thickness, and thoroughly impregnated with a moisture repellent, will be *approved*.

b. Must be protected when passing through floors, walls, partitions, timbers, etc., by non-combustible, non-absorptive, insulating tubes, such as glass or porcelain.

c. Must be kept free from contact with gas, water or other metallic piping, or any other conductors or conducting material which they may cross, by some continuous and firmly fixed non-conductor creating a separation of at least one inch. Deviations from this rule may sometimes be allowed by special permission.

d. Must be so placed in wet places that an air space will be left between conductors and pipes in crossing, and the former must be run in such a way that they cannot come in contact with the pipe accidentally. Wires should be run *over* all pipes upon which moisture is likely to gather, or which by leaking might cause trouble on a circuit.

e. Must be so spliced or joined as to be both mechanically and electrically secure without solder. They must then be soldered, to insure preservation, and covered with an insulation equal to that on the conductors.

All joints must be soldered, even if made with the McIntyre or any other patent splicing device. This ruling applies to joints and splices in all classes of wiring covered by these rules.

f. Must be protected from mechanical injury, when necessary on side walls, by a substantial boxing, retaining an air space of one inch around the conductors, closed at the top, and extending not less than five feet from the floor, or by an iron-armored or metal-sheathed insulating conduit, sufficiently strong to withstand the strain it will be subjected to, the inner insulating tubing to extend one-half inch beyond the ends of the metal tube, which must extend not less than five feet from the floor. Where crossing exposed floor timbers in cellars or rooms, the conductors must be attached by their insulating supports to the under side of a wooden strip not less than one-half inch in thickness and not less than three inches in width.

SPECIAL RULES.

19. WIRING NOT INCASED IN MOULDING OR APPROVED CONDUIT.

a. Must be supported wholly on non-combustible insulators, constructed so as to prevent the insulating coverings of the wire from coming in contact with other substances than the insulating supports.

b. Must be so arranged that wires of opposite polarity, with a difference of potential of 150 volts or less, will be kept apart at least two and one-half inches.

c. Must have the above distance increased proportionately where a higher voltage is used.

d. Must not be laid in plaster, cement or similar finish.

e. Must never be fastened with staples.

IN UNFINISHED LOFTS BETWEEN FLOOR AND CEILINGS, IN PARTITIONS AND OTHER CONCEALED PLACES.

f. Must have at least one inch clear space surrounding them.

g. Must be at least ten inches apart when possible, and should be run singly on separate timbers or studding.

h. Wires run as above immediately under roofs, in proximity to water tanks or pipes, will be considered as exposed to moisture.

i. When, from the nature of the case, it is impossible to place concealed wire on non-combustible insulating supports of glass or porcelain, the wires may be fished on the loop system, if incased throughout in *approved* continuous flexible tubing or conduit.

American Circular Loom Tubing is approved for use under this rule.

j. Wires must not be fished for any great distance, and only in places where the inspector can satisfy himself that the above rules have been complied with.

k. Twin wires must never be employed in this class of concealed work.

20. MOULDINGS :—

a. Must never be used in concealed work or in damp places.

b. Must have, both outside and inside, at least two coats of waterproof paint or be impregnated with a moisture repellent.

c. Must be made of two pieces, a backing and capping so constructed as to thoroughly incase the wire and provide a one-half-inch tongue between the conductors, and a solid backing, which, under grooves, shall not be less than three-eighths of an inch in thickness, and must afford suitable protection from abrasion.

It is recommended that only hardwood moulding be used.

21. SPECIAL WIRING :—

In breweries, packing houses, stables, dye-houses, paper and pulp mills, or other buildings specially liable to moisture or acid, or other fumes liable to injure the wires or insulation, except where used for pendants, conductors—

a. Must be separated at least six inches and should have no joints or splices.

b. Must be provided with an *approved* insulating covering.

The insulating covering of the wire to be *approved* under this section must be solid, at least 3-64th of an inch in thickness and covered with a substantial braid. It must not readily carry fire, must show an insulating resistance of one megohm per mile after two weeks' submersion in water at 70 deg. Fahr. and three days' submersion in lime water, with a current of 550 volts, after three minutes' electrification, and must *also* withstand a satisfactory test against such chemical compounds or mixtures as it will be liable to be subjected to in the risk under consideration.

c. Must be carefully put up.

d. Must be supported by glass or porcelain insulators. No switches, key sockets or fusible cut-outs will be allowed where exposed to inflammable gases or dust, or to flyings of combustible

material. In damp places switches and cut-out blocks must be mounted on porcelain knobs.

e. Must be protected when passing through floors, walls, partitions, timbers, etc., by non-combustible, non-absorptive, insulating tubes, such as glass or porcelain.

22. INTERIOR CONDUITS* :—

The American Circular Loom Company Tube, the *brass sheathed* and the *iron-armored* tube made by the Interior Conduit and Insulation Company, the *iron-armored* tube made by the Builders' Insulating Tube Company of Lynn, Mass., the *iron-armored* tube made by the Clifton Mfg. Co., of Boston, and the Vulca Tube are approved for the class of work called for in this rule.

a. Must be continuous from one junction box to another, or to fixtures, and must be of material that will resist the fusion of the wire or wires they contain without igniting the conduit.

b. Must not be of such material or construction that the insulation of the conductor will ultimately be injured or destroyed by the elements of composition.

c. Must be first installed as a complete conduit system, without the conductors, which must not be drawn in until all mechanical work on the building has been, as far as possible, completed.

d. Must not be so placed as to be subject to mechanical injury by saws, chisels or nails.

e. Must not be supplied with a twin conductor or two separate conductors in a single tube, except in an *approved* iron or steel-armored conduit.

The use of approved wires (see page 58) of opposite polarity, either separate or twin conductor, in a straight conduit installation, is allowed in *approved* iron armored or steel-armored conduits, but not in any of the other approved conduits.

Iron or steel armored conduit to be approved must fulfill the following specifications:

1. Must not be seriously affected externally by burning out a wire inside the tube when the iron pipe is connected to one side of the circuit.

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* The object of a tube or conduit is to facilitate the insertion or extraction of the conductors, to protect them from mechanical injury, and, as for as possible, from moisture. Tubes or conduits are to be considered merely as raceways, and are not to be relied on for insulation between wire and wire, or between the wire and the ground.

2. When bent with a sag of one foot in the middle of a ten-foot length, and filled with water, must have an insulation resistance between the water and the iron pipe of one megohm after three days, temperature being 21 deg. Centigrade (70 deg. Fahrenheit).

3. The insulating material removed from the tube must not absorb more than 10 per cent., by weight, of water after one week's immersion.

4. The insulating material must not soften at a temperature below 70 deg. Centigrade (158 deg. Fahrenheit), and must leave the water in which it is boiled practically neutral.

5. The insulating material must not become mechanically weak after three days' immersion in water.

f. Must have all ends closed with good adhesive material, either at junction boxes or elsewhere, whether such ends are concealed or exposed. Joints must be made air-tight and moisture-proof.

g. Conduits must extend at least one inch beyond the finished surface of walls or ceilings until the mortar or other similar material be entirely dry, when the projection may be reduced to half an inch.

23. DOUBLE-POLE SAFETY CUT-OUTS :—

a. Must be in plain sight or inclosed in an *approved* box, and readily accessible. They must not be placed in the canopies or shells of fixtures.

To be *approved*, boxes must be constructed, and cut-outs arranged, whether in a box or not, so as to obviate any danger of the melted fuse metal coming in contact with any substance which might be ignited thereby.

b. Must be placed at every point where a change is made in the size of the wire (unless the cut-out in the larger wire will protect the smaller).

c. Must be supported on bases of non-combustible, insulating, moisture-proof material.

d. Must be supplied with a plug (or other device for inclosing the fusible strip or wire) made of non-combustible and moisure-proof material, and so constructed that an arc cannot be maintained across its terminals by the fusing of the metal.

e. Must be so placed that no set of lamps, whether grouped on one fixture or on several fixtures or pendants, requiring a current

of more that six amperes, shall be ultimately dependent upon one cut-out. Special permission may be given in writing by the Inspector for departure from this rule in case of large chandeliers.

24. SAFETY FUSES:—

a. Must all be stamped or otherwise marked with the maximum number of amperes they will carry indefinitely without melting.

b. Must have fusible wires or strips (where the plug or equivalent device is not used), with contact surfaces or tips of harder metal, soldered or otherwise, having perfect electrical connection with the fusible part of the strip.

c. Must all be so proportioned to the conductors they are intended to protect that they will melt before the maximum safe-carrying capacity of the wire is exceeded.

25. TABLE OF CAPACITY OF WIRES:

It must be clearly understood that the size of the fuse depends upon the size of the smallest conductor it protects and not upon the amount of current to be used on the circuit. Below is a table showing the safe-carrying capacity of conductors of different sizes in Brown & Sharpe gauge, which must be followed in the placing of interior conductors:

	TABLE A. Concealed Work.	TABLE B. Open Work.
B. & S. G.	Amperes.	Amperes.
0000	218	312
000	181	262
00	150	220
0	125	185
1	105	156
2	88	131
3	75	110
4	63	92
5	53	77
6	45	65
8	33	46
10	25	32
12	17	23
14	12	16
16	6	8
18	3	5

NOTE.—By "open work" is meant construction which admits of all parts of the surface of the insulating covering of the wire being surrounded by *free* air. The carrying capacity of 16 and 18 wire is given, but no wire smaller than 14 is to be used, except as allowed under Rules 27 (*d*) and 31 (*a*).

26. SWITCHES:

a. Must be mounted on moisture-proof and non-combustible bases, such as slate or porcelain.

b. Must be double pole when the circuits which they control supply more than six 16-candle-power lamps, or their equivalent.

c. Must have a firm and secure contact; must make and break readily, and not stop when motion has once been imparted by the handle.

d. Must have carrying capacity sufficient to prevent heating.

e. Must be placed in dry, accessible places, and be grouped as far as possible, being mounted—when practicable—upon slate or equally non-combustible back boards. Jackknife switches, whether provided with friction or spring tops, must be so placed that gravity will tend to open rather than close the switch.

27. FIXTURE WORK:

a. In all cases where conductors are concealed within or attached to gas fixtures, the latter must be insulated from the gas-pipe system of the building by means of *approved* insulating joints placed as close as possible to the ceiling.

Insulating joints with soft rubber in their construction will not be approved. It is recommended that the gas-outlet pipe be protected above the insulating joint by a non-combustible, non-absorptive, insulating tube having a flange at the lower end, where it comes in contact with the insulating joint, and that, where outlet tubes are used, they be of sufficient length to extend below the joint, and that they be so secured that they will not be pushed back when the canopy is put in place. Where iron ceilings are used care must be taken to see that the canopy is thoroughly and permanently insulated from the ceiling.

Insulating joints to be *approved* must be entirely made of material that will resist the action of illuminating gases, and will not give way or soften under the heat of an ordinary gas flame. They shall be so arranged that a deposit of moisture will not destroy the insulating effect, and shall have an insulating resistance of 25,000 ohms between the gas-pipe attachments, and be sufficiently strong to resist the strain they will be liable to in attachment.

b. Supply conductors, and especially the splices to fixture wires, must be kept clear of the grounded part of gas pipes, and where shells are used the latter must be constructed in a manner affording sufficient area to allow this requirement.

c. When fixtures are wired outside, the conductors must be so secured as not to be cut or abraded by the pressure of the fastenings or motion of the fixture.

d. All conductors for fixture work must have a waterproof insulation that is durable and not easily abraded, and must not in any case be smaller than No. 18 B. & S., No. 20 B. W. G., No. 2 E. S. G.

e. All burs or fins must be removed before the conductors are drawn into a fixture.

f. The tendency to condensation within the pipes should be guarded against by sealing the upper end of the fixture.

g. No combination fixture in which the conductors are concealed in a space less than one-fourth inch between the inside pipe and the outsike casing will be approved.

h. Each fixture must be tested for "contacts" between conductors and fixtures, for "short circuits," and for ground connections before the fixture is connected to its supply conductors.

i. Ceiling blocks of fixtures should be made of insulating material; if not, the wires in passing through the plate must be surrounded with hard-rubber tubing.

28. Arc Lights on Low-Potential Circuits:

a. Must be connected with main conductors only through a double-pole cut-out and a double-pole switch, which shall plainly indicate whether "on" or "off."

b. Must only be furnished with such resistances or regulators as are inclosed in non-combustible material, such resistances being treated as stoves. Incandescent lamps must not be used for resistance devices.

c. Must be supplied with globes and protected as in the case of arc lights on high-potential circuits.

29. ELECTRIC GAS LIGHTING:

Where electric gas lighting is to be used on the same fixture with the electric light—

a. No part of the gas piping or fixture shall be in electrical connection with the gas-lighting circuit.

b. The wires used with the fixtures must have a non-inflammable insulation, or, where concealed between the pipe and shell of the fixture, the insulation must be such as required for fixture wiring for the electric light.

c. The whole installation must test free from "grounds."

d. Tho two installations must test perfectly free from connection with each other.

30. SOCKETS:

a. No portion of the lamp socket exposed to contact with outside objects must be allowed to come into electrical contact with either of the conductors.

b. In rooms where inflammable gases exist, or where the atmosphere is damp, the incandescent lamp and socket should be enclosed in a vapor-tight globe.

31. FLEXIBLE CORD:

a. Must be made of two-stranded conductors, each having a carrying capacity equivalent to not less than No. 16 B. & S. wire, and each covered by an *approved* insulation, and protected by a slow-burning, tough, braided outer covering.

Insulation for *pendants* under this rule must be moisture and flame-proof.

Insulation for *fixture* work must be waterproof, durable, and not easily abraded.

Insulation for cords used for all other purposes, including portable lamps and motors, must be solid, at least $\frac{1}{32}$ of an inch in thickness, and must show an insulation resistance between conductors and between either conductor and the grouud of at least one megohm per mile, after one week's immersion in water at 70 degrees Fahrenheit, with a current of 550 volts, and after three minutes' electrification.

b. Must not sustain more than one light not exceeding 50 candle-power.

c. Must not be used except for pendants, wiring of fixtures and portable lamps or motors.

d. Must not be used in show windows.

e. Must be protected by insulating bushings where the cord enters the socket. The ends of the cord must be taped to prevent fraying of the covering.

f. Must be so suspended that the entire weight of the socket and lamp will be borne by knots under the bushing in the socket, and above the point where the cord comes through the ceiling block or rosette, in order that the strain may be taken from the joints and binding screws.

g. Must be equipped with keyless sockets as far as practicable, and be controlled by wall switches.

32. DECORATIVE SERIES LAMPS:

Incandescent lamps run in series circuits shall not be used for decorative purposes inside of buildings, except by special permission in writing from the Underwriters having jurisdiction.

Class D.

ALTERNATING SYSTEMS.—CONVERTERS OR TRANSFORMERS.

33. CONVERTERS:

a. Must not be placed inside of any building, except the Central Station, unless by special permission of the Underwriters having jurisdiction.

b. Must not be placed in any but metallic or other non-combustible cases.

c. Must not be attached to the outside walls of buidings, unless separated therefrom by substantial insulating supports.

34. IN THOSE CASES WHERE IT MAY NOT BE POSSIBLE TO EXCLUDE THE CONVERTERS AND PRIMARY WIRES ENTIRELY FROM THE BUILDING, THE FOLLOWING PRECAUTIONS MUST BE STRICTLY OBSERVED:

Converters must be located at a point as near as possible to that at which the primary wires enter the building and must be placed in an inclosure constructed of, or lined with, fire-resisting material; the inclosure to be used only for this purpose, and to be kept securely locked and access to the same allowed only to responsible persons. They must be effectually insulated from the ground and the inclosure in which they are placed must be practically air-tight, except that it shall be thoroughly ventilated to the outdoor air, if possible, through a chimney or flue. There should be at least six inches air space on all sides of the converter.

35. PRIMARY CONDUCTORS:

a. Must each be heavily insulated with a coating of moisture-proof material from the point of entrance to the transformer, and, in addition, must be so covered and protected that mechanical injury to them, or contact with them, shall be practically impossible.

b. Must each be furnished, if within a building, with a switch and a fusible cut-out where the wires enter the building, or where they leave the main line. These switches should be inclosed in secure and fireproof boxes preferably outside the building.

c. Must be kept apart at least ten inches, and at the same distance from all other conducting bodies when inside a building.

36. SECONDARY CONDUCTORS:

Must be installed according to the rules for "Low-Potential Systems."

MISCELLANEOUS.

46. *a.* The wiring in any building must test free from grounds; *i.e.*, each main supply line and every branch circuit should have an installation resistance of at least 100,000 ohms and the whole installation should have an insulation resistance between conductors and between all conductors and the ground (not including attachments, sockets, receptacles, etc.) of not less than the following:

Up to	10	amperes	4,000,000
"	25	"	1,600,000
"	50	"	800,000
"	100	"	300,000
"	200	"	160,000
"	400	"	80,000
"	800	"	22,000
"	1,600	"	11,000

All cut-outs and safety devices in place in the above.

Where lamp sockets, receptacles and electroliers, etc., are connected, one-half of the above will be required.

b. Ground wires for lightning arresters of all classes, and ground detectors, must not be attached to a gas pipe within the building.

c. Where telephone, telegraph or other wires connected with outside circuits are bunched together within any building, or where inside wires are laid in conduit or duct with electric light or power wires the covering of such wires must be fire resisting, or else the wires must be inclosed in an air-tight tube or duct.

d. All aerial conductors and underground conductors; which are directly connected to aerial wires, connecting with telephone, telegraph, district messenger, burglar-alarm, watch-clock, electric time and other similar instruments, must be provided near the

point of entrance to the building with some *approved* protective device which will operate to shunt the instruments in case of a dangerous rise of potential, and will open the circuit and arrest an abnormal current flow. Any conductor normally forming an innocuous circuit may become a source of fire hazard if crossed with another conductor, through which it may become charged with a relatively high pressure.

Protectors must have a non-combustible insulating base, and the cover to be provided with a lock similar to the lock now placed on telephone apparatus or some equally secure fastening, and to be installed under the following requirements:

1. The protector to be located at the point where the wires enter the building, either immediately inside or outside of the same. If outside, the protector to be inclosed in a metallic, waterproof case.

2. If the protector is placed inside of building, the wires of the circuit from the support outside to the binding posts of the protector to be of such insulation as is approved for service wires of electric light and power, and the holes through the outer wall to be protected by bushing the same as required for electric light and power-service wires.

3. The wire from the point of entrance to the protector to be run in accordance with rules for high potential wires; *i. e.*, free of contact with building and supported on non-combustible insulators.

4. The ground wire shall be insulated, not smaller than No. 16 B. & S. gauge. This ground wire shall be kept at least three (3) inches from all conductors, and shall never be secured by uninsulated double-pointed tacks.

5. The ground wire shall be attached to a water pipe, if possible; otherwise may be attached to a gas pipe. The ground wire shall be carried to and attached to the pipe outside of the first joint or coupling inside the foundation walls, and the connection shall be made by soldering, if possible. In the absence of other good ground, the ground shall be made by means of a metallic plate or a bunch of wires buried in a permanently moist earth.

e. The metallic sheathes to cables must be permanently and effectively connected to "earth."

f. The following formula for soldering fluid is suggested.

Saturated solution of zinc	5 parts
Alcohol	4 parts
Glycerine	1 part

WIRES.

The following is a list of wires which have been tested and found to comply with the standard for *approved* wires, required for *all* high-potential work (300 volts or over); and for service wires, all classes of concealed wiring and wiring exposed to dampness in low-potential work:

NAME OF WIRE.	MANUFACTURER.
Americanite	American Electrical Works.
Bishop	Bishop Gutta Percha Co.
Clark	Eastern Electric Cable Co.
Climax	Simplex Electric Co.
Simplex (caoutchouc)	" " "
Crescent	John A. Roebling's Sons Co.
Crown	Washburn & Moen.
Globe	" "
Salamander	" " "
Crefeld	Crefeld Electric Works.
Grimshaw (White core)	N. Y. Insulated Wire Co.
Raven core	" " " "
Requa (White core)	Safety Insulated Wire & Cable Co.
Safety (Black core)	" " " " "
Habirshaw (White core)	Ind. Rubber & Gutta Percha Insulated Co.
" (Blue core)	" " " " " "
" (Red core)	" " " " " "
Paranite	Indiana Rubber & Insulated Wire Co.
Liberty	Atlas Covering Works.
Kerite	W. R. Brixey.
Okonite	The Okonite Company, Ltd., N. Y.
Paracore	Nat. India Rubber Co.
N. I. R.	" " " "
U. S.	Gen. Electric Co.
Columbia	C. S. Knowles.

NOTE.—The results of recent tests on these and other wires can be seen a inspection offices.

MATERIALS.

The following are given as a list of NON-COMBUSTIBLE, NON-ABSORPTIVE, INSULATING materials and are listed here for the benefit of those who might consider hard rubber, fiber, wood and the like as fulfilling the above requirements. Any other substance, which it is claimed should be accepted, must be forwarded for testing before being put on the market:

1. Glass.
2. Marble (filled).
3. Slate without metal veins.
4. Porcelain, thoroughly glazed and vitrified.
5 Pure Sheet Mica.
6. Lava (certain kinds of).
7. Alberene Stone.

Lundell Direct Connected Generating Sets.

For Steam Yachts, Steamships, Residences, Office Buildings, and all places where Economy of Space and Noiseless Operation is a desideratum.

Interior Conduit and Insulation Company,

General Offices and Works,

527 West Thirty-fourth Street, New York.

Interior Conduits

Iron Armored, Brass Armored, Plain.

Iron Armored Conduit possesses all the qualities of gas or water pipe, and can be installed with equal ease by the use of tools for cutting, threading, etc.

The Underwriters' "Rules and Requirements" state that the use of two Standard wires, either separate or twin conductor, in a straight conduit installation is approved in the iron armored conduit of the Interior Conduit and Insulation Company.

THE INTERIOR CONDUIT SYSTEM,

The Standard Method of Electric Wiring.

Conductors absolutely protected and insulated, and at the same time always accessible for inspection, renewals or additions.

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ELECTRICAL EQUIPMENTS

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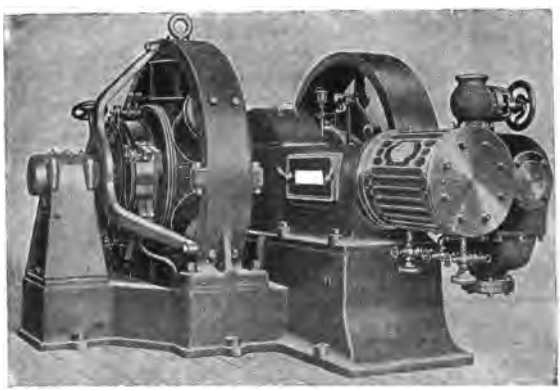

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Miniature and Decorative Lamps,
Arc Lamps for Indoor use,
Switchboards and Accessories,
Wires especially made for use in Buildings,
Safety Appliances for House Wiring.
Motors for Pumps, Ventilators, Elevators and for driving all kinds of Machinery,

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INSULATED

WIRES AND CABLES

THE OKONITE PRODUCT is perfect in workmanship and absolutely reliable. All the copper wire is of the highest grade and is drawn true throughout. It is inspected in every particular before leaving the factory, and is tested for all possible faults. The chief characteristics of this popular insulating material, which is a combination of rubber and other ingredients known only to the manufacturers, are its exceeding toughness and tenacity—rendering it non-liable to destruction by reason of abrasion or rubbing—superiority of insulation, extreme durability and effectual resistance to the decomposing influence of the elements. It is thoroughly waterproof and is warranted not to crack or deteriorate.

For electric lighting and power purposes and interior wiring Okonite has no superior. It is positively safe under the most trying conditions, and leaves an exceedingly satisfactory margin of safety beyond the most rigid rules and requirements.

Whether in mortar or cement, in mouldings or conduits, for alternating or direct systems, stranded or solid, plain or braided finish, or, in fact, whatever the specifications may be, Okonite may be relied on for the best possible results.

Samples and estimates on application.

THE OKONITE COMPANY, Limited.

WILLARD L. CANDEE, H. DURANT CHEEVER, } Business Managers.

GEO. T. MANSON, General Superintendent.
W. H. HODGINS, Secretary.

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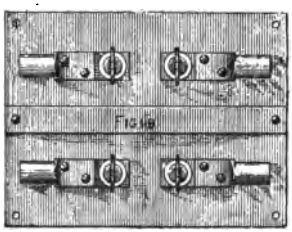


Fig. 119. Fuse Block.

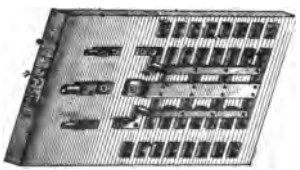


Fig. 145B. Three to Two Wire.

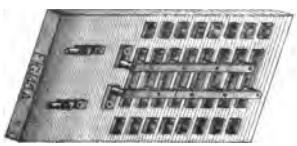


Fig. 145A. Two Wire.

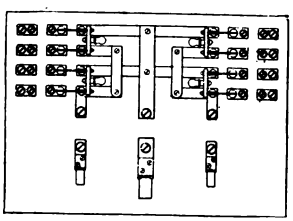
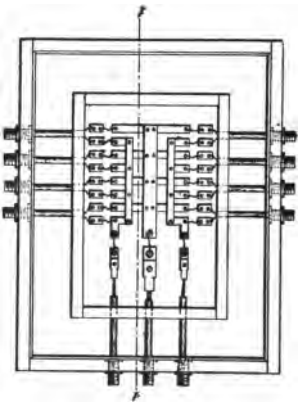


Fig. 145S. With Knife Switches.



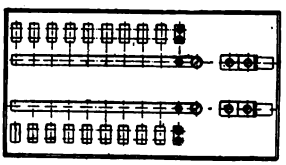


Fig. 105. Two Wire.

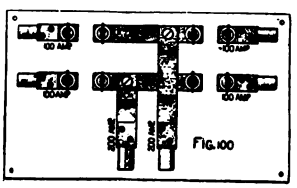
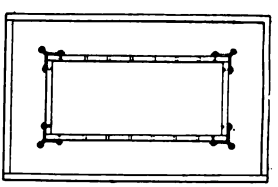


Fig. 100.
Terminal Branch Cut Out.



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