"NATIONAL ELECTRICAL CODE."

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 ASSOCIATION.

EDITION OF 1901.

The National Electrical Code, as it is here presented, is the result of the united efforts of the various Electrical, Insurance, Architectural, and allied interests which have, through the National Conference on Standard Electrical Rules, composed of delegates from various National Associations, unanimously voted to recommend it to their respective Associations for approval or adoption.

The following is a list of the Associations represented in the Conference, all of which have approved of the Code:

AMERICAN INSTITUTE OF ARCHITECTS.
AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS
AMERICAN SOCIETY OF MECHANICAL ENGINEERS
AMERICAN STREET RAILWAY ASSOCIATION
FACTORY MUTUAL FIRE INSURANCE COMPANIES
NATIONAL ASSOCIATION OF FIRE ENGINEERS
NATIONAL BOARD OF FIRE UNDERWRITERS
NATIONAL ELECTRIC LIGHT ASSOCIATION
UNDERWRITERS' NATIONAL ELECTRIC ASSOCIATION

GENERAL PLAN GOVERNING THE ARRANGEMENT OF RULES.

CLASS A.—**Central Stations, Dynamo, Motor, and Storage-Battery-Rooms, Transformer Substations, etc.** Rules 1 to 11.

CLASS B.—**Outside Work,** all systems and voltages. Rules 12 and 13.

CLASS C.—**Inside Work.** Rules 14 to 39. Subdivided as follows:
General Rules, applying to all systems and voltages. Rules 14 to 17.
Constant-Current systems. Rules 18 to 20.
Constant-Potential systems.
All voltages. Rules 21 to 23.
Voltage not over 550. Rules 24 to 31.
Voltage between 550 and 3,500. Rules 32 to 37.
Voltage over 3,500. Rules 38 and 39.

CLASS D.—**Specification** for **Wires** and **Fittings.** Rules 40 to 63.

CLASS E.—**Miscellaneous.** Rules 64 to 67.

CLASS F.—**Marine Wiring.** Rules 68 to 80.

CLASS A.—STATIONS AND DYNAMO ROOMS.

INCLUDES CENTRAL STATIONS, DYNAMO, MOTOR, AND STORAGE-BATTERY ROOMS, TRANSFORMER SUBSTATIONS, ETC.

1. Generators—

a. Must be located in a dry place.

b. Must never be placed in a room where any hazardous process is carried on, nor in places where they would be exposed to inflammable gases or flyings of combustible materials.

c. Must be insulated on floors or base frames, which must be kept filled to prevent absorption of moisture, and also kept clean and dry. Where frame insulation is impracticable, the Inspection Department having jurisdiction may, in writing, permit its omission, in which case the frame must be permanently and effectively grounded.

A high-potential machine which, on account of great weight or for other reasons, cannot have its frame insulated from the ground, should be surrounded with an insulated platform. This may be made of wood, mounted on insulating supports, and so arranged that a man must always stand upon it in order to touch any part of the machine.

In case of a machine having an insulated frame, if there is trouble from static electricity due to belt friction, it should be overcome by placing near the belt a metallic comb connected with the earth, or by grounding the frame through a very high resistance of not less than 200 ohms per volt generated by the machine.

d. Every constant-potential generator must be protected from excessive current by a safety fuse, or equivalent device, of approved design in each lead wire.

These devices should be placed on the machine or as near it as possible.

Where the needs of the service make these devices impracticable, the Inspection Department having jurisdiction may, in writing, modify the requirements.

e. Must each be provided with a waterproof cover.

f. Must each be provided with a name-plate, giving the maker's name, the capacity in volts and amperes, and the normal speed in revolutions per minute.

2. Conductors —

From generators to switchboards, rheostats, or other instruments, and thence to outside lines.

a. Must be in plain sight or readily accessible.

b. Must have an *approved* insulating covering as called for by rules in Class "C" for similar work, except that in central stations, on exposed circuits, the wire which is used must have a heavy braided non-combustible outer covering.

Bus bars may be made of bare metal.

c. Must be kept so rigidly in place that they cannot come in contact.

d. Must in all other respects be installed under the same precautions as required by rules in Class "C" for wires carrying a current of the same volume and potential.

3. Switchboards —

a. Must be so placed as to reduce to a minimum the danger of communicating fire to adjacent combustible material.

Special attention is called to the fact that switchboards should not be built down to the floor, nor up to the ceiling, but a space of at least ten or twelve inches should be left between the floor and the board, and from eighteen to twenty-four inches between the ceiling and the board in order to prevent fire from communicating from the switchboard to the floor or ceiling, and also to prevent the forming of a partially concealed space very liable to be used for storage of rubbish and oily waste.

b. Must be made of non-combustible material or of hardwood in skeleton form filled to prevent absorption of moisture.

c. Must be accessible from all sides when the connections are on the back, but may be placed against a brick or stone wall when the wiring is entirely on the face.

d. Must be kept free from moisture.

e. Bus bars must be equipped in accordance with rules for placing conductors.

4. Resistance Boxes and Equalizers —

(*For construction rules, see No. 60.*)

a. Must be placed on a switchboard or, if not thereon, at a distance of a a foot from combustible material, or separated therefrom by a non-inflammable, non-absorptive, insulating material.

5. Lightning Arresters—

(For construction rules see No. 63.)

a. Must be attached to each side of every overhead circuit connected with the station.

It is recommended to all electric light and power companies that arresters be connected at intervals over systems in such numbers and so located as to prevent ordinary discharges entering (over the wires) buildings connected to the lines.

b. Must be located in readily accessible places away from combustible materials, and as near as practicable to the point where the wires enter the building.

Station arresters should generally be placed in plain sight on the switch board.

In all cases, kinks, coils, and sharp bends in the wires between the arresters and the outdoor lines must be avoided as far as possible.

c. Must be connected with a thoroughly good and permanent ground connection by metallic strips or wires having a conductivity not less than that of a No. 6 B. & S. copper wire, which must be run as nearly in a straight line as possible from the arresters to the earth connection.

Ground wires for lightning arresters must not be attached to gas-pipes within the buildings.

It is often desirable to introduce a choke coil in circuit between the arresters and the dynamo. In no case should the ground wire from a lightning arrester be put into iron pipes, as these would tend to impede the discharge.

6. Care and Attendance.

a. A competent man must be kept on duty where generators are operating.

b. Oily waste must be kept in approved metal cans and removed daily.

Approved waste cans shall be made of metal, with legs raising can three inches from the floor, and with self-closing covers.

7. Testing of Insulation Resistance.

a. All circuits, except such as are permanently grounded in accordance with Rule 13 A, must be provided with reliable ground detectors. Detectors which indicate continuously, and give an instant and permanent indication of a ground, are preferable. Ground wires from detectors must not be attached to gas-pipes within the building.

b. Where continuously indicating detectors are not feasible, the circuits should be tested at least once per day, and preferably oftener.

c. Data obtained from all tests must be preserved for examination by the Inspection Deptrtment having jurisdiction.

These rules on testing to be applied at such places as may be designated by the Inspection Department having jurisdiction.

8. Motors—

a. Must be insulated on floors or base frames, which must be kept filled to prevent absorption of moisture ; and must be kept clean and dry. Where frame insulation is impracticable the Inspection Department having jurisdiction may, in writing, permit its omission, in which case the frame must be permanently and effectively grounded.

A high-potential machine which, on account of great weight or for other reasons, cannot have its frame insulated, should be surrounded with an insulated platform. This may be made of wood mounted on insulating supports, and so arranged that a man must stand upon it in order to touch any part of the machine.

In case of a machine having an insulated frame, if there is trouble from static electricity due to belt friction, it should be overcome by placing near the belt a metallic comb connected to the earth, or by grounding the frame through a very high resistance of not less than 200 ohms per volt generated by the machine.

b. Must be wired under the same precautions as required by rules in class "C," for wires carrying a current of the same volume and potential.

The leads or branch circuits should be designed to carry a current at least fifty per cent greater than that required by the rated capacity of the motor

to provide for the inevitable overloading of the motor at times without overfusing the wires.

c. The motor and resistance box must be protected by a cutout and controlled by a switch (see No. 17 *a*), said switch plainly indicating whether "on" or "off." Where one-fourth horse-power or less is used on low-tension circuits a single-pole switch will be accepted. The switch and rheostat must be located within sight of the motor, except in such cases where special permission to locate them elsewhere is given in writing by the Inspection Department having jurisdiction.

d. Must have their rheostats or starting-boxes located as to conform to the requirements of No. 4.

In connection with motors the use of circuit-breakers, automatic starting-boxes and automatic under-load switches is recommended, and they *must* be used when required.

e. Must not be run in series-multiple or multiple-series, except on constant-potential systems, and then only by special permission of the Inspection Department having jurisdiction.

f. Must be covered with a waterproof cover when not in use, and, if deemed necessary by the Inspection Department having jurisdiction, must be inclosed in an approved case.

From the nature of the question the decision as to what is an approved case must be left to the Inspection Department having jurisdiction to determine in each instance.

g. Must, when combined with ceiling fans, be hung from insulated hooks, or else there must be an insulator interposed between the motor and its support.

h. Must each be provided with a name-plate, giving the maker's name, the capacity in volts and amperes, and the normal speed in revolutions per minute.

9. Railway Power Plants.

a. Must be equipped in each feed wire before it leaves the station with an *approved* automatic circuit-breaker (see No. 52) or other device, which will immediately cut off the current in case of an accidental ground. This device must be mounted on a fireproof base, and in full view and reach of the attendant.

10. Storage or Primary Batteries.

a. When current for light and power is taken from primary or secondary batteries, the same general regulations must be observed as applied to similar apparatus fed from dynamo generators developing the same difference of potential.

b. Storage battery rooms must be thoroughly ventilated.

c. Special attention is directed to the rules for rooms where acid fumes exist (see No. 24, *j* and *k*).

d. All secondary batteries must be mounted on non-absorptive, non-combustible insulators, such as glass or thoroughly vitrified and glazed porcelain.

e. The use of any metal liable to corrosion must be avoided in cell connections of secondary batteries.

11. Transformers.

(*For construction rules, see No. 62.*)

a. In central or substations the transformers must be so placed that smoke from the burning out of the coils or the boiling over of the oil (where oil-filled cases are used) could do no harm.

CLASS B. — OUTSIDE WORK.

ALL SYSTEMS AND VOLTAGES.

12. Wires.

a. Service wires must have an *approved* rubber insulating covering (see No. 41). Line wires, other than services, must have an *approved* weather-proof, or rubber insulating covering (Nos. 41 and 44). All the wires must have an insulation equal to that of the conductors they confine.

b. Must be so placed that moisture cannot form a cross connection between them, not less than a foot apart, and not in contact with any substance other than their insulating supports. Service blocks must be covered over their entire surface with at least two coats of waterproof paint.

c. Must be at least seven feet above the highest point of flat roofs, and at least one foot above the ridge of pitched roofs over which they pass or to which they are attached.

d. Must be protected by dead insulated guard iron or wires from possibility of contact with other conducting wires or substances to which current may leak. Special precautions of this kind must be taken where sharp angles occur, or where any wires might possibly come in contact with electric light or power wires.

e. Must be provided with petticoat insulators of glass or porcelain. Porcelain knobs or cleats and rubber hooks will not be approved.

f. Must be so spliced or joined as to be both mechanically and electrically secure without solder. The joints 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 some form of patent splicing device. This ruling applies to joints and splices in all classes of wiring covered by these rules.

g. Must, where they enter buildings, have drip loops outside, and the holes through which the conductors must be bushed with non-combustible, non-absorptive insulating tubes slanting upward toward the inside.

h. Telegraph, telephone, and similar wires must not be placed on the same cross-arm with electric light or power wires; and when placed on the same pole with such wires the distance between the two inside pins of each cross-arm must not be less than twenty-six inches.

i. The metallic sheaths to cables must be permanently and effectively connected to "earth."

TROLLEY WIRES.

j. Must not be smaller than No. 0 B. & S. copper or No. 4 B. & S. silicon bronze, and must readily stand the strain put upon them when in use.

k. Must have a double insulation from the ground. In wooden-pole construction the pole will be considered as one insulation.

l. Must be capable of being disconnected at the power plant, or of being divided into sections, so that, in case of fire on the railway route, the current may be shut off from the particular section and not interfere with the work of the firemen. This rule also applies to feeders.

m. Must be safely protected against accidental contact where crossed by other conductors.

Guard wires should be insulated from the ground, and should be electrically disconnected in sections of not more than 300 feet in length.

GROUND RETURN WIRES.

n. For the diminution of electrolytic corrosion of underground metal work, ground return wires must be so arranged that the difference of potential between the grounded dynamo terminal and any point on the return circuit will not exceed twenty-five volts.

It is suggested that the positive pole of the dynamo be connected to the trolly line, and that whenever pipes or other underground metal work are found to be electrically positive to the rails or surrounding earth, that they be connected by conductors arranged so as to prevent as far as possible current flow from the pipes into the ground.

13. Transformers —

(*For construction rules, see No. 62.*)

a. Must not be placed inside of any building, excepting central stations, unless by special permission of the Inspection Department having jurisdiction.

b. Must not be attached to the outside walls of buildings, unless separated therefrom by substantial supports.

13. A. Grounding Low Potential Circuits.

The grounding of low potential circuits under the following regulations is only allowed when so arranged that under normal conditions there will be no flow of current through the ground wire.

Direct Current 3-Wire Systems.

a. Neutral wire may be grounded, and when grounded the following rules must be complied with: —

1. Must be grounded at the Central Station on a metal plate buried in coke beneath permanent moisture level, and also through all available underground water- and gas-pipe systems.
2. In underground systems the neutral wire must also be grounded at each distributing-box through the box.
3. In overhead systems the neutral wire must be grounded every 500 feet, as provided in Sections *c*, *e*, and *f*.

The Inspection Department having jurisdiction may require grounding if they deem it necessary.

Two-wire direct current systems having no accessible neutral point are not to be grounded.

Alternating Current Secondary Systems.

b. The neutral point of transformers, or the neutral wire of distributing systems, may be grounded, and when grounded the following rules must be complied with: —

1. Transformers feeding 2-wire systems must be grounded at the center of the secondary coils.
2. Transformers feeding systems with a neutral wire must have the neutral wire grounded at the transformer and at least every 250 feet beyond.

Inspection Department having jurisdiction may *require* grounding if they deem it necessary.

Ground Connections.

c. The ground wire in D. C. 3-wire systems must not at Central Stations be smaller than the neutral wire and not smaller than No. 6 B. & S. elsewhere.

d. The ground wire in A. C. systems must never be less than No. 6 B. & S., and must always have equal carrying capacity to the secondary lead of the transformer, or the combined leads where transformers are banked.

e. The ground wire must be kept outside of buildings, but may be directly attached to the building or pole. The wire must be carried in as nearly a straight line as possible, and kinks, coils and sharp bends must be avoided.

f. The ground connections for Central Stations, transformer substations, and banks of transformers must be made through metal plates buried in coke below permanent moisture level, and connections should also be made to all available underground piping systems. For individual transformers and building services the ground connection may be made as above, or may be made to water or other piping systems running into the buildings. This connection may be made by carrying the ground wire into the cellar and connecting on the street side of meters, main clocks, etc.

In connecting ground wires to piping systems, where possible the wires should be soldered into one or more brass plugs and the plugs forcibly screwed into a pipe-fitting, or where the pipes are cast iron into a hole tapped to the pipe itself. For large stations, where connecting to underground pipes with bell and spigot joints, it is well to connect to several lengths, as the pipe joints may be of rather high resistance. Where such plugs cannot be used the surface of the pipe may be filed or scraped bright, the wire wound around it, and a strong clamp put over the wire and firmly bolted together.

Where ground plates are used a No. 16 copper plate, about 3 x 6 feet in size, with about two feet of crushed coke or charcoal about pea size both under and over it, would make a ground of sufficient capacity for a moderate size station, and would probably answer for the ordinary sub-station

or bank of transformers. For a large Central Station considerable more area might be necessary, depending upon the other unground connections available. The ground wire should be riveted to such a plate in a number of places, and soldered for its whole length. Perhaps even better than a copperplate is a cast-iron plate with projecting forks, the idea of the fork being to distribute the connection to the ground over a fairly broad area, and to give a large surface contact. The ground wire can probably best be connected to such a cast-iron plate by brass plugs screwed into the plate to which the wire is soldered. In all cases the joint between the plate and the ground wire should be thoroughly protected against corrosion by suitable painting with waterproof paint or some equivalent.

CLASS C.—INSIDE WORK.

ALL SYSTEMS AND VOLTAGES.

GENERAL RULES—ALL SYSTEMS AND VOLTAGES.

14. Wires.

(*For special rules, See Nos. 18, 24, 32, 38, and 39.*)

a. Must not be of smaller size than No. 14 B. & S., except as allowed under Rules 24 *t* and 45 *b*.

b. Tie wires must have an insulation equal to that of the conductors they confine.

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

Standard wires must be soldered before being fastened under clamps or binding screws; and, when they have a conductivity greater than No. 10 B. & S. copper wire, they will be soldered into lugs.

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

d. Must be separated from contact with walls, floors, timbers, or partitions through which they may pass by non-combustible, non-absorptive insulating tubes, such as glass or porcelain.

Bushings must be long enough to bush the entire length of the hole in one continuous piece, or else the hole must first be bushed by a continuous waterproof tube, which may be a conductor, such as iron pipe; the tube then is to have a non-conducting bushing pushed in at each end so as to keep the wire absolutely out of contact with the conducting pipe.

e. 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.

f. 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, rather than under, pipes upon which moisture is likely to gather or which, by leaking, might cause trouble on a circuit.

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

16. Table Carrying Capacity of Wires.

Below is a table which must be followed in placing interior conductors, showing the allowable carrying capacity of wires and cables of ninety-eight per cent conductivity, according to the standard adopted by the American Institute of Electrical Engineers.

B. & S. G.	Table A. Rubber-Covered Wires. See No. 41. Amperes.	Table B. Weather-proof Wires. See No. 42 to 44. Amperes.	Circular Mills.	Circular Mills.	Table A. Rubber-Covered Wires. See No. 41. Amperes.	Table B. Weather-proof Wires. See No. 42 to 44. Amperes.
18	3	5	1,624	200,000	200	300
16	6	8	2,583	300,000	270	400
14	12	16	4,107	400,000	330	500
12	17	23	6,530	500,000	390	590
10	24	32	10,380	600,000	450	680
8	33	46	16,510	700,000	500	760
6	46	65	26,250	800,000	550	840
5	54	77	33,100	900,000	600	920
4	65	92	41,740	1,000,000	650	1,000
3	76	110	52,630	1,100,000	690	1,080
2	90	131	66,370	1,200,000	730	1,150
1	107	156	83,690	1,300,000	770	1,220
0	127	185	105,500	1,400,000	810	1,290
00	150	220	133,100	1,500 000	850	1,360
000	177	262	167,800	1,600,000	890	1,430
0000	210	312	211,600	1,700,009	930	1,490
				1,800,000	970	1,550
				1,900,000	1,010	1,610
				2,000,000	1,050	1,670

The lower limit is specified for rubber-covered wires to prevent gradual deterioration of the high insulations by the heat of the wires, but not from fear of igniting the insulation. The question of drop is not taken into consideration in the above tables.

The carrying capacity of sixteen and eighteen wire is given, but no smaller than fourteen is to be used, except as allowed under Rules 24*t* and 45 *b*.

17. Switches, Cutouts, Circuit-Breakers, etc.—

(*For construction rules, see Nos. 51, 52, and 53.*)

a. Must, whenever called for, unless otherwise provided (for exceptions, see No. 8 *c* and No. 22 *c*), be so arranged that the cutouts will protect, and the opening of the switch or circuit-breaker will disconnect, all of the wires; that is, in a two-wire system the two wires, and in a three-wire system the three wires, must be protected by the cutout, and disconnected by the operation of the switch or circuit-breaker.

b. Must not be placed in the immediate vicinity of easily ignitible stuff or where exposed to inflammable gases or dust or to flyings of combustible material.

c. Must, when exposed to dampness, either be inclosed in a waterproof box or mounted on porcelain knobs.

CONSTANT CURRENT SYSTEMS.

PRINCIPALLY SERIES ARC LIGHTING.

18. Wires—

(*See also Nos. 14, 15, and 16.*)

a. Must have an *approved* rubber insulating covering (see No. 41).

b. Must be arranged to enter and leave the building through an *approved* double-contact service switch (see No. 51), mounted in a non-combustible case, kept free from moisture, and easy of access to police or firemen. So-called "snap switches" must not be used on high-potential circuits.

c. Must always be in plain sight, and never incased, except when *required* by the Inspection Department having jurisdiction.

d. Must be supported on glass or porcelain insulators, which separate the wire at least one inch from the surface wired over, and must be kept *rigidly* at least eight inches from each other, except within the structure of lamps, on hanger-boards, in cutout boxes, or like places, where a less distance is necessary.

e. Must, on side walls, be protected from mechanical injury by a substantial boxing, retaining an air space of one inch around the conductors, closed at the top (the wires passing through bushed holes), and extending not less than seven feet from the floor. When crossing floor-timbers in cellars or in rooms, where they might be exposed to injury, wires must be attached by their insulating supports to the underside of a wooden strip not less than one-half an inch in thickness.

19. Arc Lamps—

(*For construction rules, see No. 57.*)

a. Must be carefully isolated from inflammable material.

b. Must be provided at all times with a glass globe surrounding the arc, securely fastened upon a closed base. No broken or cracked globes to be used.

c. Must be provided with a wire netting (having a mesh not exceeding one and one-fourth inches) around the globe, and an *approved* spark arrester (see No. 58), when readily inflammable material is in the vicinity of the lamps, to prevent escape of sparks, melted copper or carbon. It is recommended that plain carbons, not copper-plated, be used for lamps in such places.

Arc lamps, when used in places where they are exposed to flyings of easily inflammable material, should have the carbons inclosed completely in a globe in such manner as to avoid the necessity for spark arresters.

For the present, globe and spark arresters will not be required on so-called "inverted arc" lamps, but this type of lamp must not be used where exposed to flyings of easily inflammable materials.

d. Where hanger-boards (see No. 56) are not used, lamps must be hung from insulating supports other than their conductors.

20. Incandescent Lamps in Series Circuits—

a. Must have the conductors installed as provided in No. 18, and each lamp must be provided with an automatic cutout.

b. Must have each lamp suspended from a hanger-board by means of rigid tube.

c. No electro-magnetic device for switches and no system of multiple-series or series-multiple lighting will be approved.

d. Under no circumstances can they be attached to gas fixtures.

CONSTANT POTENTIAL SYSTEMS.

GENERAL RULES, ALL VOLTAGES.

21. Automatic Cutouts (Fuses and Circuit-Breakers).

(*See No. 17, and for construction Nos. 52 and 53.*)

a. Must be placed on all service wires, either overhead or underground, as near as possible to the point where they enter the building and inside the walls, and arranged to cut off the entire current from the building.

Where the switch required by rule No. 22 is inside the building, the cutout required by this section must be placed so as to protect it.

b. Must be placed at every point where a change is made in the size of wire [unless the cutout in the larger wire will protect the smaller (see No. 16)].

c. Must be in plain sight, or inclosed in an *approved* box (see No. 54) and readily accessible. They must not be placed in the canopies or shells of fixtures.

d. Must be so placed that no set of incandescent lamps, whether grouped on one fixture or several fixtures or pendants, requiring more than 660 watts, shall be dependent upon one cutout. Special permission may be given in writing by the Inspection Department having jurisdiction for departure from this rule in case of large chandeliers, stage borders, and illuminated signs.

e. Must be provided with fuses, the rated capacity of which does not exceed the allowable carrying capacity of the wire; and, when circuit-breakers are used, they must not be set more than about thirty per cent above the allowable carrying capacity of the wire, unless a fusible cutout is also installed in the circuit (see No. 16).

22. Switches—

(*See No. 17, and for construction No. 51.*)

a. Must be placed on all service wires, either overhead or underground, in a readily accessible place, as near as possible to the point where the wires enter the building, and arranged to cut off the entire current.

b. Must always be placed in dry, accessible places, and be grouped as far as possible. Knife switches must be so placed that gravity will tend to open rather than close the switch.

c. Must not be single-pole, except when the circuits which they control supply not more than six 16-candle power lamps or their equivalent.

d. Where flush-switches are used, whether with conduit systems or not, the switches must be inclosed in boxes constructed of or lined with fire-resisting material. No push-buttons for bells, gas-lighting circuits or the like shall be placed in the same wall-plate with switches controlling electric light or power wiring.

23. Electric Heaters—

a. Must, if stationary, be placed in a safe situation, isolated from inflammable materials, and be treated as sources of heat.

b. Must each have a cutout and *indicating*-switch (see No. 17 *a*).

c. Must have the attachments of feed wires to the heaters in plain sight, easily accessible, and protected from interference, accidental or otherwise.

d. The flexible conductors for portable apparatus, such as irons, etc., must have an *approved* insulating covering (see No. 45 *h*).

e. Must each be provided with name-plate, giving the maker's name and the normal capacity in volts and amperes.

LOW POTENTIAL SYSTEMS.

550 VOLTS OR LESS.

Any circuit attached to any machine, or combination of machines, which develops a difference of potential, between any two wires, of over ten volts and less than 550 volts, shall be considered as a low-potential circuit, and as coming under this class, unless an approved transforming device is used, which cuts the difference of potential down to ten volts or less. The primary circuit not to exceed a potential of 3,500 volts.

24. Wires—

GENERAL RULES.

(*See also Nos. 14, 15, and 16.*)

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

b. Must never be fastened with staples.

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

d Twin wires must never be used, except in conduits, or where flexible conductors are necessary.

e. Must be protected on side walls from mechanical injury. When crossing floor-timbers in cellars or in rooms, where they might be exposed to injury, wires 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.

Suitable protection on side walls may be secured by a substantial boxing, retaining an air space of one inch around the conductor, closed at the top (the wires passing through bushed holes), 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; or plain metal pipe, lined with insulating tubing which must extend one-half inch beyond the end of the metal tube.

The pipe must extend not less than five feet above the floor, and may extend through the floor in place of a floor bushing.

If iron pipes are used with alternating currents, the two or more wires of a circuit *must* be placed in the same conduit. In this case the insulation of each wire must be reinforced by a tough conduit tubing projecting beyond the ends of the iron pipe at least two inches.

f. When run immediately under roofs, or in proximity to water tanks or pipes, will be considered as exposed to moisture.

SPECIAL RULES.

For open work:

In dry places:

g. Must have an *approved* rubber or "slow-burning" waterproof insulation (see Nos. 41 and 42).

h. Must be rigidly supported on non-combustible, non-absorptive insulators, which separate the wires from each other and from the surface wired over in accordance with following table:

VOLTAGE.	DISTANCE FROM SURFACE.	DISTANCE BETWEEN WIRES.
0 to 225	½ inch.	2½ inches.
225 " 550	1 "	4 "

Rigid supporting requires under ordinary conditions, where wiring along flat surfaces, supports at least every four and one-half feet. If the wires are liable to be disturbed, the distance between supports should be shortened. In buildings of mill construction, mains of No. 8 B. & S. wire or over, where not liable to be disturbed, may be separated about four inches, and run from timber to timber, not breaking around, and may be supported at each timber only.

This rule will not be interpreted to forbid the placing of the neutral of a three-wire system in the center of a three-wire cleat, provided the outside wires are separated in accordance with above table.

In damp places, such as Breweries, Sugar Houses, Packing Houses, Stables, Dye Houses, Paper or Pulp Mills, or buildings specially liable to moisture, or acid, or other fumes liable to injure the wires or their insulation, except where used for pendants:

i. Must have an *approved* rubber insulating covering (see No. 41).

j. Must be rigidly supported on non-combustible, non-absorptive insulators, which separate the wire at least one inch from the surface wired over, and they must be kept apart at least two and one-half inches.

Rigid supporting requires under ordinary conditions, where wiring over flat surfaces, supports at least every four and one-half feet. If the wires are liable to be disturbed, the distance between supports should be shortened. In buildings of mill construction, mains of No. 8 B. & S. wire or over, where not liable to be disturbed, may be separated about four inches, and run from timber to timber, not breaking around, and may be supported at each timber only.

k. Must have no joints or splices.

For molding work:

l. Must have *approved* rubber insulation covering (see No. 41).

m. Must never be placed in molding in concealed or damp places.

For conduit work:

n. Must have an *approved* rubber insulating covering (see No. 47).

o. Must not be drawn in until all mechanical work on the building has been, as far as possible, completed.

p. **Must,** for alternating systems, have the two or more wires of a circuit drawn in the same conduit.

It is advised that this be done for direct-current systems also, so that they may be changed to alternating systems at any time, induction troubles preventing such a change unless this construction is followed.

For concealed "knob and tube" work:

q. Must have an *approved* rubber insulating covering (see No. 41).

r. Must be rigidly supported on non-combustible, non-absorptive insulators which separate the wire at least one inch from the service wired over, and must be kept at least ten inches apart, and, when possible, should be run singly on separate timbers or studding.

Rigid supporting requires under ordinary conditions, where wiring along flat surfaces, supports at least every four and one-half feet. If the wires are liable to be disturbed, the distance between supports should be shortened.

s. When, from the nature of the case, it is impossible to place concealed wiring on non-conbustible, insulating supports of glass or porcelain, an *approved* armored cable with single or twin conductors (see No. 48) may be used where the difference of potential between wires is not over 300 volts, provided it is installed without joints between outlets, and the cable armor properly enters all fittings and is rigidly secured in place; or, if the difference of potential between wires is not over 300 volts, and if wires are not exposed to moisture, they may be fished on the loop system if separately incased throughout in approved flexible tubing or conduits.

For fixture work:

t. Must have an *approved* rubber insulating covering (see No. 46), and shall not be less in size than No. 18 B. & S.

u. Supply conductors, and especially the splices to fixtures 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.

v. Must, when fixtures are wired outside, be so secured as not to be cut or abraded by the pressure of the fastenings or motion of the fixture.

25. Interior Conduits.

(*See also Nos. 24 n to p, and 49.*)

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 far as possible, from moisture. Tubes or conduits are to be considered merely as raceways, and are not to be relied upon for insulation between wire and wire, or between the wire and the ground.

a. No conduit tube having an internal diameter of less than five-eights of an inch shall be used. (If conduit is lined, measurement to be taken inside of lining.)

b. Must be continuous from one junction box to another or to fixtures, and the conduit tube must properly enter all fittings.

c. Must be first installed as a complete conduit system, without the conductors.

d. Must be equipped at every outlet with an *approved* outlet box.

e. Metal conduits, where they enter junction boxes, and at all other outlets, etc., must be fitted with a capping of *approved* insulating material, fitted so as to protect wire from abrasion.

f. Must have the metal of the conduit permanently and effectively grounded.

26. Fixtures—

(*See also No. 24 t to v.*)

a. Must, when supported from the gas-piping of a building, be insulated from the gas-pipe system by means of *approved* insulating joints (see No. 59) placed as close as possible to the ceiling.

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 insulating 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.

b. Must have all burs, or fins, removed before the conductors are drawn into the fixture.

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

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

e. Must be tested for "contacts" between conductors and fixture, for "short circuits," and for ground connections before it is connected to its supply conductors.

f. Ceiling blocks for fixtures should be made of insulating material; if not the wires in passing through the plate must be surrounded with non-combustible non-absorptive, insulating material, such as glass or porcelain.

g. Under no conditions shall there be a difference of potential of more than 300 volts between wires contained in or attached to the same fixture.

27. Sockets.

(*For construction rules, see No. 55.*)

a. In rooms where inflammable gases may exist the incandescent lamp and socket must be inclosed in a vapor-tight globe, and supported on a pipe hanger, wired with *approved* rubber-covered wire (see No. 41) soldered directly to the circuit.

b. In damp or wet places, or over specially inflammable stuff, waterproof sockets must be used.

When waterproof sockets are used, they should be hung by separate stranded rubber-covered wires, not smaller than No. 14 B. & S., which should preferably be twisted together when the drop is over three feet. These wires should be soldered direct to the circuit wires, but supported independently of them.

28. Flexible Cord —

a. Must have an *approved* insulation and covering (see No. 45).

b. Must not be used where the difference of potential between the two wires is over 300 volts.

c. Must not be used as a support for clusters.

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

e. Must not be used in show windows.

f. Must be protected by insulating bushings where the cord enters the socket.

g. Must be so suspended that the entire weight of the socket and lamp will be born 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.

29. Arc Lights on Low-Potential Circuits —

a. Must have a cutout (see No. 17*a*) for each lamp of each series of lamps.

The branch conductors should have a carrying capacity about fifty per cent in excess of the normal current required by the lamp to provide for heavy current required when lamp is started or when carbons become stuck without overfusing the wires.

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

c. Must be supplied with globes and protected by spark arresters and wire netting around globe, as in the case of arc lights on high-potential circuits (see Nos. 19 and 58).

30. Economy Coils.

a. Economy and compensator coils for arc lamps must be mounted on non-conbustible, non-absorptive insulating supports, such as glass or porcelain, allowing an air space of at least one inch between frame and support, and in general to be treated like sources of heat.

31. Decorative Series Lamps.

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

32. Car-Wiring —

a. Must be always run out of reach of the passengers, and must have an *approved* rubber-insulating covering (see No. 41).

33. Car-Houses —

a. Must have the trolley wires securely supported on insulating hangers.
b. Must have the trolley hangers placed at such distance apart that, in case of a break in the trolley wire, contact cannot be made with the floor.
c. Must have cutout switch located at a proper place outside of the building, so that all trolley circuits in the building can be cut out at one point, and line circuit-breakers must be installed, so that when this cutout switch is open the trolley wire will be dead at all points within 100 feet of the building. The current must be cut out of the building whenever the same is not in use or the road not in operation.
d. Must have all lamps and stationary motors installed in such a way that one main switch can control the whole of each installation — lighting or power — independently of main feeder-switch. No portable incandescent lamps or twin wire allowed, except that portable incandescent lamps may be used in the pits, connections to be made by two *approved* rubber-covered flexible wires (see No. 41), properly protected against mechanical injury; the circuit to be controlled by a switch placed outside of the pit.
e. Must have all wiring and apparatus installed in accordance with rules under Class "C" for constant-potential systems.
f. Must not have any system of feeder distribution centering in the building.
g. Must have the rails bonded at each joint with no less than No. 2 B. & S. annealed copper wire, also a supplementary wire to be run for each track.
h. Must not have cars left with trolley in electrical connection with the trolley wire.

34. Lighting and Power from Railway Wires —

a. Must not be permitted, under any pretense, in the same circuit with trolley wires with a ground return, except in electric railway cars, electric car houses and their power stations; nor shall the same dynamo be used for both purposes.

HIGH-POTENTIAL SYSTEMS.

550 TO 3,500 VOLTS.

Any circuit attached to any machine, or combination of machines, which develops a difference of potential, between any two wires, of over 300 volts and less than 3,500 volts, shall be considered as a high-potential circuit, and as coming under that class, unless an approved transforming device is used, which cuts the difference of potential down to 300 volts or less.

35. Wires —

(*See also Nos. 14, 15, and 16.*)

a. Must have an *approved* rubber-insulating covering (see No. 41).
b. Must be always in plain sight and never incased, except where required by the Inspection Department having jurisdiction

c. Must be rigidly supported on glass or porcelain insulators, which raise the wire at least one inch from the surface wired over, and must be kept apart at least four inches for voltages up to 750 and at least eight inches for voltages over 750.

Rigid supporting requires under ordinary conditions, where wiring along flat surfaces, supports at least about every four and one-half feet. If the wires are unusually liable to be disturbed, the distance between supports should be shortened.

In buildings of mill construction, mains of No. 8 B. & S. wire or over, where not liable to be disturbed, may be separated about six inches for voltages up to 750 and about ten inches for voltages above 750; and run from timber to timber, not breaking around, and may be supported at each timber only.

d. Must be protected on side walls from mechanical injury by a substantial boxing, retaining an air space of one inch around the conductors, closed at the top (the wires passing through bushed holes) and extending not less than seven feet from the floor. When crossing floor-timbers, in cellars or in rooms, where they might be exposed to injury, wires must be attached by their insulating supports to the under side of a wooden strip not less than one-half an inch in thickness.

36. Transformers (when permitted inside buildings, see No. 13)—

(*For construction rules, see No. 62.*)

a. Must be located at a point as near as possible to that at which the primary wires enter the building.

b. 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.

c. 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 transformer.

37. Series Lamps.

a. No system of multiple-series or series-multiple for light or power will be approved.

b. Under no circumstances can lamps be attached to gas fixtures.

EXTRA HIGH POTENTIAL SYSTEMS.

OVER 3,500 VOLTS.

Any circuit attached to any machine or combination of machines, which develops a difference of potential, between any two wires, of over 3,500 volts, shall be considered as an extra high-potential circuit, and as coming under that class, unless an approved transforming device is used, which cuts the difference of potential down to 3,500 volts or less.

38. Primary Wires—

a. Must not be brought into or over building, except power and substations.

39. Secondary Wires—

a. Must be installed under rules for high-potential systems, when their immediate primary wires carry a current of over 3,500 volts, unless the primary wires are entirely underground, within city and village limits.

The presence of wires carrying a current with a potential of over 3,500 volts in the streets of cities, towns, and villages is considered to increase the fire hazard. Extra high potential circuits are also objectionable in any location where telephone, telegraph, and similar circuits run in proximity to them. As the underwriters have no jurisdiction over streets and roads they can only take this indirect way of discouraging such systems; but further, it is strongly urged that municipal authorities absolutely refuse to grant any franchise for right of way for overhead wires carrying a current of extra high potential through streets or roads which are used to any great extent for public travel or for trunk-line, telephone, or telegraph circuits.

CLASS D. FITTINGS, MATERIALS, AND DETAILS OF CONSTUCTION.

ALL SYSTEMS AND VOLTAGES. INSULATED WIRES — RULES 40 to 48.

40. General Rules.

a. Copper for insulated conductors must never vary in diameter so as to be more than two one-thousandths of an inch less than the specified size.

b. Wires and cables of all kinds designed to meet the following specifications must be plainly tagged or marked as follows:

1. The maximum voltage at which the wire is designed to be used.
2. The words "National Electrical Code Standard."
3. Name of the manufacturing company, and, if desired, trade-name of the wire.
4. Month and year when manufactured.

41. Rubber-Covered.

a. Copper for conductors must be thoroughly tinned.

Insulation for voltages between 0 and 600.

b. Must be of rubber or other approved substance, and be of a thickness not less than that given in the following table for B. & S. gauge sizes:

From	18 to	16, inclusive,	$\frac{1}{32}$″
"	14 to	8, "	$\frac{2}{64}$″
"	7 to	2, "	$\frac{3}{64}$″
"	1 to	0000, "	$\frac{4}{64}$″
"	0000 to	500,000, C. M.	$\frac{5}{64}$″
"	500,000 to	1,000,000, "	$\frac{6}{64}$″
Larger than		1,000,000, "	$\frac{7}{64}$″

Measurements of insulating wall are to be made at the thinnest portion of the dielectric.

c. The completed coverings must show an insulation resistance of at least 100 megohms per mile during thirty days' immersion in water at seventy degrees Fahrenheit.

d. Each foot of the completed covering must show a dieletric strength sufficient to resist throughout five minutes the application of an electro-motive force of 3,000 volts per one-sixty-fourth of an inch thickness of insulation under the following conditions:

The source of alternating electro-motive force shall be a transformer of at least one kilowatt capacity. The application of the electro-motive force shall first be made at 4,000 volts for five minutes, and then the voltage increased by steps of not over 3,000 volts, each held for five minutes, until the rupture of the insulation occurs. The tests for dielectric strength shall be made on a sample of wire which has been immersed for seventy-two hours in water, one foot of which is submerged in a conducting liquid held in a metal trough, one of the transformer terminals being connected to the wire and the other to the metal of the trough.

Insulations for voltages between 600 and 3,500:

e. The thickness of the insulating walls must not be less than those given in the following table for B. & S. gauge sizes:

From 14 to 1, inclusive, $\frac{3}{32}$″

From 0 to 500,000, C. M., $\frac{3}{32}$″ covered by a tape or a braid.

Larger than 500,000, C. M., $\frac{4}{32}$″ covered by a tape or a braid

f. The requirements as to insulation and break-down resistance for wires for low potential systems shall apply, with the exception that an insulation resistance of not less than 300 megohms per mile shall be required.

g. Wire for arc-light circuits exceeding 3,500 volts potential shall have an insulating wall not less than six-thirty-seconds of an inch in thickness, and shall withstand a break-down test of at least 30,000 volts, and have an insulation of at least 500 megohms per mile.

The tests on this wire to be made under the same conditions as for low-potential wires.

Specifications for insulations for alternating currents exceeding 3,500

volts have been considered, but on account of the somewhat complex conditions in such work it has so far been deemed inexpedient to specify general insulations for this use.

h. All of the above insulations must be protected by a substantial braided covering properly saturated with a preservative compound and sufficiently strong to withstand all the abrasion likely to be met with in practice, and sufficiently elastic to permit all wires smaller than No. 7 B. & S. gauge to be bent around a cylinder with twice the diameter of the wire, without injury to the braid.

42. Slow-burning Weatherproof.

a. The insulation shall consist of two coatings, the inner one to be fireproof in character, the outer to be weatherproof. The inner fireproof coating must comprise at least six-tenths of the total thickness of the wall. The completed covering must be of a thickness not less than that given in the following table for B. & S. gauge sizes:

From	14 to	8, inclusive,	$\frac{3}{64}$″
"	7 to	2,	$\frac{1}{16}$″
"	2 to	0000,	$\frac{5}{64}$″
"	0000 to	500,000, C. M.,	$\frac{3}{32}$″
"	500,000 to	1,000,000, "	$\frac{7}{64}$″
Larger than		1,000,000, "	$\frac{1}{8}$″

Measurements of insulating wall are to be made at the thinnest portion of the dielectric.

b. The inner fireproof coating shall be layers of cotton or other thread, the outer one of which must be braided. All the interstices of these layers are to be filled with the fireproofing compound. This is to be material whose solid constituent is not susceptible to moisture, and which will not burn even when ground in an oxidizable oil, making a compound which, while proof against fire and moisture, at same time has considerable elasticity, and which when dry will suffer no change at a temperature of 250 degrees Fahrenheit, and which will not burn at even higher temperature.

c. The weatherproof coating shall be a stout braid thoroughly saturated with a dense moistureproof compound thoroughly slicked down, applied in such manner as to drive any atmospheric moisture from the cotton braiding, thereby securing a covering to a greater degree waterproof and of high insulating power. This compound to retain its elasticity at zero Fahrenheit, and not to drip at 160 degrees Fahrenheit.

This wire is not as burnable as the old "weatherproof," nor as subject to softening under heat, but still is able to repel the ordinary amount of moisture found indoors. It would not usually be used for outside work.

43. Slow-burning.

a. The insulation shall be the same as the "slow-burning weatherproof," except that the outer braiding shall be impregnated with a fireproofing compound similar to that required for the interior layers, and with the outer surface finished smooth and hard.

This "slow-burning" wire shall only be used with special permission of the Inspection Department having jurisdiction.

This is practically the old "Underwriters'" insulation. It is specially useful in hot, dry places where ordinary insulations would perish, also where wires are bunched, as on the back of a large switchboard or in a wire tower so that the accumulation of rubber or weatherproof insulation would result in an objectionably large mass of highly inflammable material.

Its use is restricted, as its insulating qualities are not high and are damaged by moisture.

44. Weatherproof.

a. The insulating covering shall consist of at least three braids thoroughly impregnated with a dense moisture repellent, which will not drip at a temperature lower than 180 degrees Fahrenheit. The thickness of insulation shall be not less than that of "slow-burning weatherproof." The outer surface shall be thoroughly slicked down."

This wire is for outdoor use where moisture is certain and where fireproof qualities are not necessary.

45. Flexible Cord —

a. Must be made of stranded copper conductors, each strand to be not larger than No. 26 or smaller than No. 30 B. & S. gauge, and each stranded conductor must be covered by an approved insulation and protected from mechanical injury by a tough braided outer covering.

For pendent lamps:

In this class is to be included all flexible cord which under usual conditions hangs freely in air, and which is not likely to be moved sufficiently to come in contact with surrounding objects.

b. Each stranded conductor must have a carrying capacity equivalent to not less than a No. 18 B. & S. gauge wire.

c. The covering of each stranded conductor must be made up as follows:

1. A tight, close wind of fine cotton.
2. The insulation proper, which shall be either waterproof or slow-burning.
3. An outer cover of silk or cotton.

The wind of cotton tends to prevent a broken strand puncturing the insulation and causing a short circuit. It also keeps the rubber from corroding the copper.

d. Waterproof insulation must be solid, at least one-thirty-second of an inch thick, and must show an insulation resistance of fifty megohms per mile throughout two weeks' immersion in water at 70 degrees Fahrenheit, and stand the test prescribed for low-tension wires as far as they apply.

e. Slow-burning insulation must be at least one-thirty-second of an inch in thickness, and composed of substantial, elastic, slow-burning materials, which will suffer no damage at a temperature of 250 degrees Fahrenheit.

f. The outer protecting braiding should be so put on and sealed in place that when cut it will not fray out, and where cotton is used, it should be impregnated with a flameproof paint, which will not have an injurious effect on the insulation.

For portables:

In this class is included all cord used on portable lamps, small portable motors, etc.

g. Flexible cord for portable use must have waterproof insulation as required in section *d* for pendent cord, and in addition be provided with a reinforcing cover especially designed to withstand the abrasion it will be subject to in the uses to which it is to be put.

For portable heating apparatus:

h. Must be made up as follows: —

1. A tight, close wind of fine cotton.
2. A thin layer of rubber about one-one-hundredth of an inch thick, or other cementing material.
3. A layer of asbestos insulation at least three-sixty-fourths of an inch thick.
4. A stout braid of cotton.
5. An outer reinforcing cover especially designed to withstand abrasion.

This cord is in no sense waterproof, the thin layer of rubber being specified in order that it may serve merely as a seal to help hold in place the fine cotton and asbestos, and it should be so put on as to accomplish this.

46. Fixture Wire —

a. Must have a solid insulation, with a slow-burning, tough, outer covering, the whole to be at one-thirty-second of an inch in thickness, and show an insulation resistance between conductors, and between either conductor and the ground, of at least one megohm per mile, after one week's submersion in water at seventy degrees Fahrenheit, and after three minutes' electrification with 550 volts.

47. Conduit Wire —

Must comply with the following specifications:

a. For metal conduits, having a lining of insulating material, single wires

must comply with No. 41, and all duplex, twin, and concentric conductors must comply with No. 41, and must also have each conductor separately braided or taped and a substantial braid covering the whole.

b. For unlined metal conduits, conductors must conform to the specifications given for lined conduits, and in addition have a second outer fibrous covering at least one-thirty-second of an inch in thickness, and sufficiently tenacious to withstand the abrasion of being hauled through the metal conduit.

The braid required around each conductor in duplex, twin, and concentric cables is to hold the rubber insulation in place and prevent jamming and flattening.

48. Armored Cable.

a. The armor of such cables must be at least equal in thickness and of equal strength to resist penetration by nails, etc., as the armor of metal covering of metal conduits (see No. 49 *b*).

b. The conductors in same, single wire or twin conductors, must have an insulating covering as required by No. 41, any filler used to secure a round exterior must be impregnated with a moisture repellent, and the whole bunch of conductors and fillers must have a separate exterior covering of insulating material at least one-thirty-second of an inch in thickness, conforming to the insulation standard given in No. 41, and covered with a substantial braid.

Very reliable insulation is specified, as such cables are liable to hard usage, and in part of their length may be subject to moisture, while they may not be easily removable, so that a breakdown of insulation is likely to be expensive.

49. Interior Conduits.

(*For wiring rules, see Nos. 24 and 25.*)

a. Each length of conduit, whether insulated or uninsulated, must have the maker's name or initials stamped in the metal or attached thereto in a satisfactory manner, so that the inspectors can readily see the same.

METAL CONDUITS WITH LINING OF INSULATING MATERIAL.

b. The metal covering or pipe must be equal in strength to the ordinary commercial forms of gas-pipe of the same size, and its thickness must be not less than that of standard gas-pipe, as shown by the following table :

Size. Inches.	Thickness of Wall — Inches.	Size. Inches.	Thickness of Wall — Inches.
$\frac{3}{8}$	.109	$1\frac{1}{2}$	.140
$\frac{1}{2}$	.111	$1\frac{1}{4}$	.145
$\frac{3}{4}$	.113	2	.154
1	.134		

An allowance of two one-hundredths of an inch for variation in manufacturing and loss of thickness by cleaning will be permitted.

c. 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.

d. Must have the insulating lining firmly secured to the pipe.

e. The insulating lining must not crack or break when a length of the conduit is uniformly bent at temperature of 212 degrees Fahrenheit to an angle of ninety degrees, with a curve having a radius of fifteen inches, for pipes of one inch and less, and fifteen times the diameter of pipe for larger pipes.

f. The insulating lining must not soften injuriously at a temperature below 212 degrees Fahrenheit, and must leave water in which it is boiled practically neutral.

g. The insulating lining must be at least one-thirty-second of an inch in thickness ; and the materials of which it is composed must be of such a nature as will not have a deteriorating effect on the insulation of the conductor, and be sufficiently tough and tenacious to withstand the abrasion test of drawing long lengths of conductors in and out of same.

h. The insulating lining must not be mechanically weak after three days' submersion in water, and when removed from the pipe entire must not absorb more than ten per cent of its weight of water during 100 hours of submersion.

i. All elbows or bends must be so made that the conduit or lining of same will not be injured. The radius of the curve of the inner edge of any elbow not to be less than three and one-half inches. Must have not more than the equivalent of four quarter bends from outlet to outlet, the bends at the outlets not being counted.

UNLINED METAL CONDUITS.

j. Plain iron or steel pipes of equal thickness and strengths specified for lined conduits in No. 49 *b* may be used as conduits, provided their interior surfaces are smooth and free from burs; pipe to be galvanized, or the interior surfaces coated or enameled, to prevent oxidation, with some substance which will not soften so as to become sticky and prevent wire from being withdrawn from the pipe.

k. All elbows or bends must be so made that the conduit will not be injured. The radius of the curve of the inner edge of any elbow not to be less than three and one-half inches. Must have not more than the equivalent of four quarter bends from outlet to outlet, the bends at the outlet not being counted.

50. Wooden Moldings—

(*For wiring rules, see No. 24.*)

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

b. 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 molding be used.

51. Switches—

(*See Nos. 17 and 22.*)

a. Must be mounted on non-combustible, non-absorptive, insulating bases, such as slate or porcelain.

b. Must have carrying capacity sufficient to prevent undue heating,

c. Must, when used for service switches, indicate, on inspection, whether the current be "on" or "off."

d. Must be plainly marked, where it will always be visible, with the name of the maker and the current and voltage for which the switch is designed.

e. Must, for constant potential systems, operate successfully at fifty per cent overload in amperes, with twenty-five per cent excess voltage under the most severe conditions they are liable to meet with in practice.

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

g. Must, for constant current systems, close the main circuit and disconnect the branch wires when turned "off"; must be so constructed that they shall be automatic in action, not stopping between points when started, and must prevent an arc between the points under all circumstances. They must indicate, upon inspection, whether the currents be "on" or "off."

52. Cutouts and Circuit-Breakers—

(*For installation rules, see Nos. 17 and 21.*)

a. Must be supported on bases of non-combustible, non-absorptive insulating material.

b. Cutouts must be provided with covers, when not arranged in approved cabinets, so as to obviate any danger of the melted fuse metal coming in contact with any substance which might be ignited thereby.

c. Cutouts must operate successfully, under the most severe conditions they are liable to meet with in practice, on short circuits with fuses rated at fifty per cent above, and with a voltage twenty-five per cent above the current and voltage for which they are designed.

d. Circuit-breakers must operate successfully, under the most severe conditions they are liable to meet with in practice, on short circuits when set at fifty per cent above the current, and with a voltage twenty-five per cent above that for which they are designed.

e. Must be plainly marked, where it will always be visible, with the name of the maker, and current and voltage for which the device is designed.

53. Fuses —

(For installation rules, see Nos. 17 and 21.)

a. Must have contact surfaces or tips of harder metal having perfect electrical connection with the fusible part of the strip.

b. Must be stamped with about eighty per cent of the maximum current they can carry indefinitely, thus allowing about twenty-five per cent overload before fuse melts.

With naked open fuses, of ordinary shapes and not over 500 amperes capacity, the *maximum* current which will melt them in about five minutes may be safely taken as the melting point, as the fuse practically reaches its maximum temperature in this time. With larger fuses a longer time is necessary.

Inclosed fuses where the fuse is often in contact with substances having good conductivity to heat and often of considerable volume, require a much longer time to reach a maximum temperature, on account of the surrounding material which heats up slowly.

These data are given to facilitate testing.

c. Fuse terminals must be stamped with the maker's name, initials, or some known trade-mark.

54. Cutout Cabinets —

a. Must be so constructed, and cutouts so arranged, as to obviate any danger of the melted fuse metal coming in contact with any substance which might be ignited thereby.

A suitable box can be made of marble, slate, or wood, strongly put together, the door to close against a rabbet so as to be perfectly dust-tight; and it should be hung on strong hinges, and held closed by a strong hook or catch. If the box is wood, the inside should be lined with sheets of asbestos board about one-sixteenth of an inch in thickness, neatly put on, and firmly secured in place by shellac and tacks. The wire should enter through holes bushed with porcelain bushings; the bushings tightly fitting the holes in the box, and the wires tightly fitting the bushings (using tape to build up the wire, if necessary) so as to keep out the dust.

55. Sockets.

(See No. 27.)

Sockets of all kinds, including wall receptacles, must be constructed in accordance with the following specifications:—

a. STANDARD SIZES. — The standard lamp socket shall be suitable for use on any voltage not exceeding 250 and with any size lamp up to fifty candle-power. For lamps larger than fifty candle-power a standard keyless socket may be used; or if a key is required, a special socket designed for the current to be used must be made. Any special sockets must follow the general spirit of these specifications.

b. MARKING. — The standard socket must be plainly marked fifty candle-power, 250 volts, and with either the manufacturer's name or registered trademark. Special large sockets must be marked with the current and voltage for which they are designed.

c. SHELL. — Metal used for shells must be moderately hard, but not hard enough to be brittle or so soft as to be easily dented or knocked out of place. Brass shells must be at least 0.013 inch in thickness, and shells of any other material must be thick enough to give the same stiffness and strength of brass.

d. LINING. — The inside of the shells must be lined with insulating material, which shall absolutely prevent the shell from becoming a part of the circuit, even though the wires inside the socket should start from their position under binding screws.

The material used for lining must be at least one thirty-second of an inch in thickness, and must be tough and tenacious. It must not be injuriously affected by the heat from the largest lamp permitted in the socket, and must leave the water in which it is boiled practically neutral. It must be so firmly secured to the shell that it will not fall out with ordinary handling of the socket. It is preferable to have the lining in one piece.

e. CAP. — Caps when of sheet brass must be at least 0.013 inch in thickness, and when cast or made of other metals must be of equivalent strength. The inlet piece, except for special sockets, must be tapped and threaded for ordinary one-eight-inch pipe. It must contain sufficient metal for a full, strong thread, and, when not of the same piece as the cap, must be joined to it in a way to give the strength of a single piece.

There must be sufficient room in the cap to enable the ordinary wireman to easily and quickly make a knot in the cord, and push it into place in cap without crowding. All parts of the cap upon which the knot is likely to bear must be smooth and well insulated.

f. FRAME AND SCREWS. — The frame holding moving parts must be sufficiently heavy to give ample strength and stiffness.

Brass pieces containing screw threads must be at least 0.06 of an inch in thickness.

Binding-post screws must not be smaller than No. 5 wire and about forty threads per inch.

g. SPACING. — Points of opposite polarity must everywhere be kept not less than three sixty-fourths of an inch apart unless separated by a reliable insulation.

h. CONNECTIONS. — The connecting points for the flexible cord must be made to very securely grip a No. 16 or 18 B. & S. conductor. A turned-up lug, arranged so that the cord may be gripped between the screw and the lug in such a way that it cannot possibly come out, is strongly advised.

i. LAMP-HOLDER. — The socket must firmly hold the lamp in place so that it cannot be easily jarred out, and must provide a contact good enough to prevent undue heating with maximum current allowed. The holding-pieces, springs and the like, if a part of the circuit, must not be sufficiently exposed to allow them to be brought in contact with anything outside of lamp and socket.

j. BASE. — The inside parts of the socket, which are of insulating material, except the lining, must be made of porcelain.

k. KEY. — The socket key-handle must be of such a material that it will not soften from the heat of a fifty candle-power lamp hanging downwards in air at seventy degrees Fahrenheit from the socket, and must be securely, but not necessarily rigidly, attached to the metal spindle it is designed to turn.

l. SEALING. — All screws in porcelain pieces, which can be firmly sealed in place, must be so sealed by a waterproof compound which will not melt below 200 degrees Fahrenheit.

m. PUTTING TOGETHER. — The socket must, as a whole, be so put together that it will not rattle to pieces. Bayonet joints or equivalent are recommended.

n. TEST. — The socket when slowly turned "on and off," at the rate of about two or three times per minute, must "make and break" the circuit 6,000 times before failing, when carrying a load of one ampere at 220 volts.

o. KEYLESS SOCKETS. — Keyless sockets of all kinds must comply with requirements for key sockets as far as they apply.

p. SOCKETS OF INSULATING MATERIALS. — Sockets made of porcelain or other insulating material must conform to the above requirements as far as they apply, and all parts must be strong enough to withstand a moderate amount of hard usage without breaking.

q. INLET BUSHING. — When the socket is not attached to fixtures the threaded inlet must be provided with a strong insulating bushing, having a *smooth* hole of at least fifteen sixty-fourths of an inch in diameter. The corners of the bushing must be rounded, and all inside fins removed, so that in no place will the cord be subjected to the cutting or wearing action of a sharp edge.

56. Hanger-boards.

a. Hanger-boards must be so constructed that all wires and current-carrying devices thereon shall be exposed to view, and thoroughly insulated by being mounted on a non-combustible, non-absorptive insulating substance. All switches attached to the same must be so constructed that they shall be automatic in their action, cutting off both poles to the lamp, not stopping between points when started, and preventing an arc between points under all circumstances.

57. Arc Lamps.

(*For installation rules, see No. 19.*)

a. Must be provided with reliable stops to prevent carbons from falling out in case the clamps become loose.

b. Must be carefully insulated from the circuit in all their exposed parts.

c. Must, for constant-current systems, be provided with an *approved* hand switch, also an automatic switch that will shunt the current around the carbons, should they fail to feed properly.

The hand switch to be approved, if placed anywhere except on the lamp itself, must comply with requirements for switches on hanger-boards as laid down in No. 56.

58. Spark Arresters.

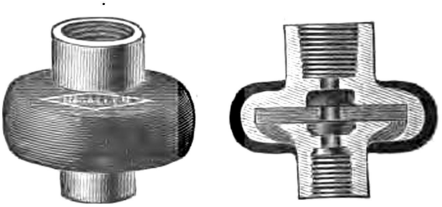
(*See No. 19 c.*)

a. Spark arresters must so close the upper orifice of the globe that it will be impossible for any sparks thrown off by the carbons to escape.

59. Insulating Joints –

(*See No. 26 a.*)

a. 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, or leak under a moderate pressure. They shall be so arranged that a deposit of moisture will not destroy the insulating effect, and shall have an insulating resistance of at least 250,000 ohms between the gas-pipe attachments, and be sufficiently strong to resist the strain they will be liable to be subjected to in being installed.



Insulating Joint for Gas Pipes.

b. Insulating joints having soft rubber in their construction will not be approved.

60. Resistance Boxes and Equalizers –

(*For installation rules, see No. 4.*)

a. Must be equipped with metal or with other non-combustible frames. The word "frame" in this section relates to the entire case and surroundings of the rheostat, and not alone to the upholding supports.

61. Reactive Coils and Condensers.

a. Reactive coils must be made of non-combustible material, mounted on non-combustible bases, and treated, in general, like sources of heat.

b. Condensers must be treated like apparatus operating with equivalent voltage and currents. They must have non-combustible cases and supports, and must be isolated from all combustible materials, and, in general, treated like sources of heat.

62. Transformers —

(*For installation rules, see Nos. 11, 13, and 33.*)

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

b. Must be constructed to comply with the following tests:

1. Shall be run for eight consecutive hours at a full load in watts under conditions of service, and at the end of that time the rise in temperature, as measured by the increase of resistance of the primary coil, shall not exceed 135 degrees Fahrenheit.
2. The insulation of transformers when heated shall withstand continuously for five minutes a difference of potential of 10,000 volts (alternating) between primary and secondary coils and core, and between the primary coils and core and a no-load "run" at double voltage for thirty minutes.

63. Lightning Arresters.

(*For installation rules, see No. 5.*)

a. Must be mounted on non-combustible bases, and must be so constructed as not to maintain an arc after the discharge has passed, and must have no moving parts.

CLASS E. — MISCELLANEOUS.

64. Signaling Systems (governing wiring for telephone, telegraph, district messenger, and call-bell circuits, fire and burglar alarms, and all similar systems) —

a. Outside wires should be run in underground ducts or strung on poles and, as far as possible, kept off of buildings, and must not be placed on the same cross-arm with electric light or power wires.

b. When outside wires are run on same pole with electric light or power wires, the distance between the two inside pins of each cross-arm must not be less than twenty-six inches.

c. All aerial conductors and underground conductors which are directly connected to aerial wires must be provided with some approved protective device, which shall be located as near their point of entrance to the building as possible, and not less than six inches from curtains or other inflammable material.

d. If the protector is placed inside of building, wires, from outside supports to binding-posts of protector, shall comply with the following requirements:

1. Must be of copper, and not smaller than No. 16 B. & S. gauge.
2. Must have an *approved* rubber insulating covering (see No. 41).
3. Must have drip loops in each wire immediately outside the building.
4. Must enter buildings through separate holes sloping upward from the outside; when practicable, holes to be bushed with non-absorptive, non-combustible insulating tubes extending through their entire length. Where tubing is not practicable, the wires shall be wrapped with two layers of insulating tape.
5. Must be supported on porcelain insulators, so that they will not come in contact with anything other than their designed supports.
6. A separation between wires of at least two and one-half inches must be maintained.

In case of crosses these wires may become a part of a high-voltage circuit, so that similar care to that given high-voltage circuits is needed in placing them. Reliable porcelain bushings at the entrance holes are desirable, and are only waved under adverse conditions, because the state of the art in this type of wiring makes an absolute requirement inadvisable.

e. The ground wire of the protective device shall be run in accordance with the following requirements:

1. Shall be of copper, and not smaller than No. 16 B. & S.
2. Must have an *approved* rubber insulating covering (See No. 41).
3. Shall run in as straight a line as possible to a good permanent ground, to be made by connecting to water- or gas-pipe, preferably water-pipe. If gas-pipe is used, the connection, in all cases, must be made between the meter and service pipes. In the absence of other good ground, the ground shall be made by means of a metallic plate or bunch of wires buried in permanently moist earth.
4. Shall be kept at least three inches from all other conductors, and supported on porcelain insulators so as not to come in contact with anything other than its designated supports.

In attaching a ground wire to a pipe, it is often difficult to make a thoroughly reliable solder joint. It is better, therefore, where possible, to carefully solder the wire to a brass plug, which may then be firmly screwed into a pipe fitting.

Where such joints are made under ground, they should be thoroughly painted and taped to prevent corrosion.

f. The protector to be approved must comply with the following requirements:

1. Must be mounted on non-combustible, non-absorptive insulating bases, so designed that when the protector is in place, all parts which may be alive will be thoroughly insulated from the wall holding the protector.
2. Must have the following parts:

   A lightning arrester which will operate with a difference of potential between wires of not over 500 volts, and so arranged that the chance of accidental grounding is reduced to a minimum.

   A fuse designed to open the circuit in case the wires become crossed with light or power circuits. The fuse must be able to open the circuit without arcing or serious flashing when crossed with any ordinary commercial light or power circuit.

   A heat coil which will operate before a sneak current can damage the instrument the protector is guarding.

   The heat coil is designed to warm up and melt out with a current large enough to endanger the instruments if continued for a long time, but so small that it would not blow the fuses ordinarily found necessary for such instruments. These smaller currents are often called "sneak" currents.
3. The fuses must be so placed as to protect the arrester and heat coils, and the protector terminals must be plainly marked "line," "instrument," "ground."

g. Wires beyond the protector, except where bunched, must be neatly arranged and securely fastened in place in any convenient, workmanlike manner. They must not come nearer than six inches to any electric light or power wire in the building, unless incased in approved tubing so secured as to prevent its slipping out of place.

The wires would ordinarily be insulated, but the kind of insulation is not specified, as the protector is relied upon to stop all dangerous currents. Porcelain tubing or circular loom conduit may be used for incasing wires where required as above.

h. Wires connected with outside circuits, where bunched together within any building, or inside wires, where laid in conduits or ducts, with electric light or power wires, must have fire-resisting coverings, or else must be inclosed in an air-tight tube or duct.

It is feared that if a burnable insulation were used, a chance spark might ignite it and cause a serious fire, for many installations contain a large amount of very readily burnable matter.

65. 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 electric 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. The two installations must test perfectly free from connection with each other.

66. Insulation Resistance.

The wiring in any building must test free from grounds; i. e., the complete installation must have an insulation between conductors and between all conductors and the ground (not including attachments, sockets, receptacles, etc.) of not less than the following:

Up to	5 amperes	4,000,000	ohms.
"	10 "	2,000,000	"
"	25 "	800,000	"
"	50 "	400,000	"
"	100 "	200,000	"
"	200 "	100,000	"
"	400 "	25,000	"
"	800 "	25,000	"
"	1,600 "	12,500	"

All cutouts 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.

67. Soldering Fluid.

a. The following formula for soldering fluid is suggested:

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

CLASS F. — MARINE WORK.

68. Generators —

a. Must be located in a dry place.

b. Must have their frames insulated from their bed-plates.

c. Must each be provided with a waterproof cover.

d. Must each be provided with a name-plate, giving the maker's name, the capacity in voltage and amperes and normal speed in revolutions per minute —

69. Wires —

a. Must have an *approved* insulating covering.

The insulation for all conductors, except for portables, to be approved, must be at least one-eighth-inch in thickness and be covered with a substantial waterproof and flameproof braid. The physical characteristics shall not be affected by any change in temperature up to 200 degrees Fahrenheit. After two weeks' submersion in salt water at seventy degrees Fahrenheit it must show an insulation resistance of one megohm per mile after three minutes' electrification, with 550 volts.

b. Must have no single wire larger than No. 12 B. & S. Wires to be stranded when greater carrying capacity is required. No single solid wire smaller than No. 14 B. & S., except in fixture wiring, to be used.

Stranded wires must be soldered before being fastened under clamps or binding screws, and when they have a conductivity greater than No. 10 B. & S. copper wire they must be soldered into lugs.

c. Must be supported in approved molding, except at switchboards and portables.

Special permission may be given for deviation from this rule in dynamo-rooms.

d. Must be bushed with hard-rubber tubing one-eighth of an inch in thickness when passing through beams and non-water-tight bulkheads.

e. Must have, when passing through water-tight bulkheads and through all decks, a metallic stuffing-tube lined with hard rubber. In case of deck tubes they shall be boxed near deck to prevent mechanical injury.

f. Splices or taps in conductors must be avoided as far as possible. Where it is necessary to make them they must be so spliced or joined as to be both mechanically and electrically secure without solder. They must then be soldered, to insure preservation, covered with an insulating compound equal to the insulation of the wire, and further protected by a waterproof tape. The joint must then be coated or painted with a waterproof compound.

70. Portable Conductors—

a. Must be made of two stranded conductors, each having a carrying capacity equivalent to not less than No. 14 B. & S. wire, and each covered with an approved insulation and covering.

Where not exposed to moisture or severe mechanical injury, each stranded conductor must have a solid insulation at least one-thirty-second of an inch in thickness, and must show an insulation resistance between conductors and between either conductor and the ground, of at least one megohm per mile after one week's submersion in water at seventy degrees Fahrenheit and after three minutes' electrification, with 590 volts, and be protected by a slow-burning, tough-braided outer covering.

Where exposed to moisture and mechanical injury—as for use on decks, holds, and fire-rooms—each stranded conductor shall have a solid insulation to be approved, of at least one-thirty-second of an inch in thickness and protected by a tough braid. The two conductors shall then be stranded together, using a jute filling. The whole shall then be covered with a layer of flax, either woven or braided, at least one-thirty-second of an inch in thickness, and treated with a non-inflammable waterproof compound. After one week's submersion in water at seventy degrees Fahrenheit, at 550 volts and a three minutes' electrification, must show an insulation between the two conductors, or between either conductor and the ground, of one megohm per mile.

71. Bell or Other Wires—

a. Shall never run in same duct with lightning or power wires.

72. Table of Capacity of Wires.

B. & S. G.	Area Actual C. M.	No. of Strands.	Size of Strands B. & S. G.	Amperes.
19	1,288	..	..	..
18	1,624	..	..	3
17	2,048	..	..	..
16	2,583	..	..	6
15	3,257	..	..	..
14	4,107	..	..	12
12	6,530	..	..	17
..	9,016	7	19	21
..	11,368	7	18	25
..	14,336	7	17	30
..	18,081	7	16	35
..	22,799	7	15	40
..	30,856	19	18	50
..	38,912	19	17	60
..	49,077	19	16	70
..	60,088	37	18	85
..	75,776	37	17	100
..	99,064	61	18	120
..	124,928	61	17	145
..	157,563	61	16	170
..	198,677	61	15	200
..	250,527	61	14	235
..	296,387	91	15	270
..	373,737	91	14	320
..	413,639	127	15	340

When greater conducting area than that of a single wire is required, the conductor shall be stranded in a series of **7, 19, 37, 61, 91,** or **127,** wires as may be required; the strand consisting of one central wire, the remainder laid around it concentrically, each layer to be twisted in the opposite direction from the preceding

73. Switchboards —

a. Must be made of non-combustible, non-absorbtive insulating material, such as marble or slate.

b. Must be kept free from moisture, and must be located so as to be accessible from all sides.

c. Must have a main switch, main cutout, and ammeter for each generator.

Must also have a voltmeter and ground detector.

d. Must have a cutout and switch for each side of each circuit leading from board.

74. Resistance Boxes —

a. Must be made of non-combustible material.

b. Must be located on switchboard or away from combustible material. When not placed on switchboard they must be mounted on non-inflammable, non-absorptive insulating material.

c. Must be so constructed as to allow sufficient ventilation for the uses to which they are put.

75. Switches —

a. Must have non-combustible, non-absorptive insulating bases.

b. Must operate successfully at fifty per cent overload in amperes with twenty-five per cent excess voltage under the most severe conditions they are liable to meet with in practice, and must be plainly marked, where they will always be visible, with the name of the maker and the current and voltage for which the switch is designed.

c Must be double pole when circuits which they control supply more than six sixteen-candle-power lamps or their equivalent.

d. When exposed to dampness, they must be inclosed in a water-tight case.

76. Cutouts —

a. Must have non-combustible, non-absorptive insulating bases.

b. Must operate successfully, under the most severe conditions they are liable to meet with in practice, on short circuit with fuse rated at fifty per cent above, and with a voltage twenty-five per cent above the current and voltage they are designed for, and must be plainly marked, where they will always be visible, with the name of the maker and current and voltage for which the device is designed.

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

d. In places such as upper decks, holds, cargo spaces, and fire-rooms a water-tight and fireproof cutout may be used, connecting directly to mains when such cutout supplies circuits requiring not more than 660 watts energy.

e. When placed anywhere except on switchboards and certain places, as cargo spaces, holds, fire-rooms, etc., where it is impossible to run from center of distribution, they shall be in a cabinet lined with fire-resisting material.

f. Except for motors, searchlights, and diving-lamps shall be so placed that no group of lamps, requiring a current of more than six amperes, shall ultimately be dependent upon one cutout.

A single-pole covered cutout may be placed in the molding when same contains conductor supplying circuits requiring not more than 220 watts energy.

77. Fixtures —

a. Shall be mounted on blocks made from well-seasoned lumber treated with two coats of white lead or shellac.

b. Where exposed to dampness, the lamp must be surrounded by a vapor-proof globe.

c. Where exposed to mechanical injury the lamp must be surrounded by a globe protected by a stout wire guard.

d. Shall be wired with same grade of insulation as portable conductors which are not exposed to moisture or mechanical injury.

78. Sockets.

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

79. Wooden Mouldings—

a. Must be made of well-seasoned lumber and be treated inside and out with at least two coats of white lead or shellac.

b. Must be made of two pieces, a backing and a 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.

c. Where molding is run over rivets, beams, etc., a backing strip must first be put up and the molding secured to this.

d. Capping must be secured by brass screws.

80. Motors—

a. Must be wired under the same precautions as with a current of same volume and potential for lighting. The motor and resistance box must be protected by a double-pole cutout, and controlled by a double-pole switch, except in cases where one-quarter horse-power or less is used.

The leads or branch circuits should be designed to carry a current at least fifty per cent greater than that required by the rated capacity of the motor to provide for the inevitable overloading of the motor at times.

b. Must be thoroughly insulated. Where possible, should be set on base frames made from filled, hard, dry, wood, and raised above surrounding deck. On hoists and winches they shall be insulated from bed-plates by hard rubber, fiber, or similar insulating material.

c. Shall be covered with a waterproof cover when not in use.

d. Must each be provided with a name-plate giving maker's name, the capacity in volts and amperes, and the normal speed in revolutions per minute.

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, except for constant-current systems, the work should, if possible, be started from a center of distribution, and the switches and cutouts, 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 indorsed 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.