

# NATIONAL ELECTRICAL CODE

EDITION OF 1918

## CLASS "C"—INSIDE WORK

(Including all Work for Light, Power and Heat, Protected by Service Cut-out and Switch,  
For Signaling Systems see Class E.)

### ALL SYSTEMS AND VOLTAGES

#### GENERAL RULES

##### 15A. Method of Grounding, When Protective Grounding is Required.

(What to ground see Nos. 1c, 1d, 5c, 7a, 8a, b, 11b, 12f, 15a, b, 25e, 27c, 28f, 29e, 43e, 45c, 86b.)

###### a. General Provisions.

Where low potential circuits are grounded under the following rules, circuits must be so arranged that under normal conditions of service there will be no appreciable passage of current over the ground conductor.

When arresters, equipment, wire raceways, etc., are grounded under the following rules, ground connections must be so disposed and underground piping systems so interconnected, that there shall, under normal conditions, be no appreciable passage of current over the ground conductor.

###### Direct Current Systems. Point of Attachment.

b. In three-wire direct-current systems the ground connection must be made on the neutral and at one or more supply stations, but not at individual services or within buildings served.

c. In two-wire direct-current systems the ground connection must be at one station only.

###### Alternating-Current Systems. Point of Attachment.

d. The ground connection for alternating current systems must be made at the building service or near the transformer (or transformers) either by direct ground connection, through water piping system or artificial ground, or by the use of a system ground wire to which are connected the grounded conductors of many secondary mains and which itself is effectually grounded at intervals that will fulfill, for any secondary utilizing the system ground wire, the resistance and current-carrying requirements for Ground Conductors section *k* and Ground Connection section *l*.

Where the secondaries of transformers are supplying a common set of mains, fuses if

installed must be installed only at such points as will not cause the loss of the ground connections after any fuses in the transformer circuits or mains have been blown.

Multiple grounds are preferable in most cases, but grounds, other than the single ground connection at the building service, must not be made to alternating current secondaries within the building served.

e. In single phase, three-wire systems, the ground must be on the neutral conductor.

f. In single phase, two-wire systems, the ground may be on either of the conductors.

g. In two-wire single phase, and in two or three phase systems, the ground must be connected at that point of the system which brings about the lowest voltage from ground of unguarded current-carrying parts of connected devices and also permits of most convenient grounding. Where any phase of a two or three phase system is used for lighting, that phase should be grounded and at the neutral conductor, if one is used.

###### Lightning Arresters and Ground Detectors.

h. For lightning arresters and ground detectors, the ground connection must be at such a point that its ground conductor is as short and straight as practicable.

###### Equipment and Wire Raceways.

i. For generators, motors, transformers, conduit, armored cable, metal raceways, etc., the point at which the ground conductor is attached must, if practicable, be readily accessible.

For conduit, armored cable or metal raceways the ground conductor must be as near as practicable to the point where the conductors in the conduit system concerned receive their supply.

When the service conduit is grounded, its ground conductor must be run direct from it to the ground connection. The interior conduit, armored cable or metal raceways, if well bonded to service conduit, grounded as provided in this rule, need no additional ground connection.

## Ground Conductors.

j. In all cases, the ground conductor must be of copper or of other metal which will not corrode excessively under the existing conditions, and if practicable must be without joint or splice.

The insulation and installation of the ground conductor for circuits must comply with all the requirements of the Code for wires of the voltage of the circuit to which the ground conductor is attached and must have after January 1, 1919, an identifying covering. In all cases the ground conductor must be protected against mechanical injury. Protection for lightning arrester ground conductors must be of non-magnetic material unless the ground conductor is electrically connected to both ends of the protective device. In no case shall an automatic cut-out be inserted in a ground conductor or connection, except in ground conductors for equipment where its operation will disconnect all leads connected to the equipment from the circuit conductors.

k. The ground conductor or conductors for circuits must, in general, have combined current capacity sufficient to insure the continuity and continued effectiveness of the ground connection under conditions of excess current caused by accidental grounding of any normally ungrounded conductor of the circuit.

The ground conductor for a three-wire direct-current system must have a combined current capacity not smaller than the neutral wire to which it is attached.

The ground conductor for alternating current systems must not be smaller than No. 6 copper wire, nor smaller than one-fifth the current capacity of the wire to which it is attached, except that it need not be larger than No. 0 copper wire.

Lightning arrester ground connections must not be made to the same artificial ground (driven pipes or buried plates) as circuits or equipment, but must be well spaced and when practicable kept at least 20 feet from other artificial grounds.

l. For lightning arresters, the ground conductor must have a current capacity sufficient to insure the continuity and continued effectiveness of the ground connection under conditions of excess current caused by or following discharge of arrester.

No individual ground conductor shall have a smaller current capacity than No. 6 B. & S. gage copper wire.

m. For the frames of electrical equipment the current capacity of the ground conductor must not be less than that provided by copper wire of the size indicated in the following table.

With portable equipment protected by fuses not greater than 15 amperes, No. 14 ground wire may be used.

| Capacity of nearest cut-out protecting the equipment. | Required size of ground conductor. |
|---|------------------------------------|
| 0 to 100 amperes                                      | No. 10 B. & S. gage                |
| 101 to 200 "  | No. 6 B. & S. "                    |
| 201 to 500 "  | No. 4 B. & S. "                    |
| 501 amperes and above                                 | No. 2 B. & S. "                    |

The grounded circuit wires must not be used as ground wire for equipment, etc., and ground conductors from equipment, etc., must not be connected to grounded circuit wires.

n. If an armored cable system, a conduit system or a metal raceway system, consist of several separate sections, the sections must be bonded to each other, and the system grounded, or each section may be separately grounded.

The armor of conduits, cables, metal raceways and gas pipes must either be securely fastened in outlet boxes, junction boxes and cabinets, so as to secure good electrical connection, or the separate sections, boxes and cabinets must be separately grounded.

Where short sections of conduit (or pipe of equivalent strength) are used for the protection of exposed wiring on side walls and such conduit or pipe and wiring is installed as required in No. 26e, the conduit or pipe need not be grounded.

Ground wires must be of copper or other metal which will not corrode excessively under the existing conditions. They must be at least equivalent to No. 10 B. & S. gage copper (where largest wire contained is not greater than No. 0 B. & S. gage) and need not be greater than No. 4 B. & S. gage (where the largest wire contained is greater than No. 0 B. & S. gage), and for service conduit the ground shall not be less than No. 6 B. & S. gage copper.

The grounded circuit wires must not be used as ground wire for conduits, cables, metal raceways and ground conductors from conduits, cables and metal raceways must not be connected to ground circuit wires.

If conduit, couplings or fittings having protective coating of non-conducting material, such as enamel, are used, such coating must be thoroughly removed from threads of both couplings and conduit and such surfaces or fittings where the conduit or ground clamp is secured, in order to obtain the requisite good connection. Grounded pipes must be clean of rust, scale, etc., at the place of attachment of ground clamp.

## Ground Connection.

o. The ground connection must be permanent and effective and be made as indicated below, but always to water piping system if available.

The protective grounding of electrical circuits and equipment to water piping systems, in accordance with these rules, should always be permitted, since such grounding offers the most efficient protection to life and property and is not injurious to the piping systems.

For circuits, equipment and arresters at supply stations, connections must be made to all available active, continuous, metallic underground water piping systems between which no appreciable difference of potential normally exists and to one such system if appreciable differences of potential do exist between them. At other places connection must be made to at least one such system if available. Gas piping must be avoided

wherever practicable except as permitted in last paragraph of section *q* below.

Where underground metallic piping systems are not available, other methods which will secure the desired permanence and conductance may be permitted.

*p.* Protective ground connections for other than electric railway lightning arresters must not be made to railway negative return circuits when other effective means of grounding are available.

*q.* Ground connections to metallic piping systems must be made on the street side of water meters, but connections may be made immediately inside building walls to secure accessibility for inspection and test. When water meters are located outside buildings or in concrete pits within buildings where piping connections are imbedded in concrete flooring, the ground connection may be made on the building side of the meters, if they are suitably shunted.

When the making of a ground to a piping system outside meter or other device would involve a long run, connection for equipment or wire runways may be made to the water piping system at a point near the part to be protected, provided there are no insulating joints in the pipe to prevent a good ground. In such cases care should be taken to electrically connect all parts of the piping system liable to create a hazard and to shunt the pipe system where necessary around meters, etc., in order to keep the connection with the underground piping system continuous.

Gas piping systems within buildings should not be used for purposes of this rule, except where water piping systems are not available and then only for grounding of equipment, metal raceways, etc., also excepting that gas piping need not be insulated from otherwise well-grounded electrical fixtures and where the making of another ground connection for a fixture would involve a long run and the fixture is therefore, of course, not within reach of plumbing or plumbing fixtures, the gas piping may for small fixtures be utilized as the sole ground connection. Where gas piping is so used it must be bonded to the water piping systems within the building at their points of entrance.

*r.* The ground connections to metallic piping systems must be made by means of an approved clamp which is bolted around the pipe after all rust and scale have been removed, or by means of a brass plug tightly screwed into pipe or fitting, or by other equivalent means.

The ground wire must be attached to the clamp or to the plug by means of solder or by an approved solderless connector.

The point of connection should preferably be in plain sight and as readily accessible as possible.

*s.* Artificial grounds should be located where practicable below permanent moisture level. Each ground must present not less than 4 square feet surface to exterior soil. Areas where ground water level is close to the surface should be used when available.

Where ground plates are used they should

be at least No. 16 Stubbs gage copper; when driven pipes are used they should be of galvanized iron and not smaller than one inch internal diameter; and when cast iron plates are used they should be at least one-quarter inch in thickness.

*t.* The combined resistances of the ground wires and connections of any grounded circuit, equipment, or lightning arrester should not exceed 3 ohms for water pipe connections nor 25 ohms for artificial grounds where these must be used. Where, because of dry or other high resistance soils it is impracticable to obtain artificial ground resistance as low as 25 ohms, two such grounds 6 feet apart if practicable must be installed, and no requirement will be made as to resistance.

## 16. Wires.

(See also Nos. 17, 18, 20, 26, 27, 44, 47 and 48.)

For construction rules see Nos. 49 to 57.)

*a.* Must not be of smaller size than No. 14 B. & S. gage, except as allowed for fixture work and pendant cord.

*b.* Conductors of size No. 8 B. & S. gage or over used in connection with solid knobs must be securely tied thereto. If wires are used for tying they must have an insulation of the same type as the conductors they confine.

Knobs or cleats which are arranged to grip the wire, must be fastened by either screws or nails. If nails are used, they must be long enough to penetrate the woodwork not less than one-half the length of the knob and fully the thickness of the cleat, and must be provided with washers which will prevent, under reasonable usage, injury to the knobs or cleats.

*c.* Must be so spliced or joined as to be both mechanically and electrically secure without solder. The joints must then be soldered unless made with some form of approved splicing device, and covered with an insulation equal to that on the conductors.

Stranded wires (except in flexible cords) must be soldered before being fastened under clamps or binding screws, and whether stranded or solid, when they have a conductivity greater than that of No. 8 B. & S. gage they must be soldered into lugs for all terminal connections, except where an approved solderless terminal connector is used.

*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, except at outlets where approved flexible tubing is required.

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. This tube may be a conductor, such as iron pipe, but in that case an insulating bushing must be pushed into each end of it, extending far enough to keep the wire absolutely out of contact with the pipe.

*e.* Where not enclosed in approved conduit, raceways and armored cable, and where liable to come in contact with gas, water, or other metallic piping or other conducting material,

must be separated therefrom by some continuous and firmly fixed non-conductor creating a permanent separation. Must not come nearer than two (2) inches to any other electric lighting, power or signaling wire, not enclosed as above, without being permanently separated therefrom by some continuous and firmly fixed non-conductor. The non-conductor used as a separator must be in addition to the regular insulation on the wires. Where tubes are used, they must be securely fastened at the ends to prevent them from moving along the wire.

Deviations from this rule may, when necessary, 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.

g. The installation of electrical conductors in raceways, or on insulators, in elevator shafts will not be approved, but conductors may be installed in such shafts if encased in approved metal conduits, or armored cables.

h. In three-wire (not three-phase) systems, the neutral must be of sufficient capacity to carry the maximum current to which it may be subjected.

#### 17. Underground Conductors.

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

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

c. Where underground service enters building through tubes, the tubes shall be tightly closed at outlets with asphaltum or other non-conductor, to prevent gases from entering the building through such channels.

d. No underground service from a subway to a building, and no service from a private generating plant, shall supply more than one building, except by special permission, unless the conductors are properly protected by fuses and are carried outside all the buildings but the one served. Conductors in conduit or duct under two inches of concrete under a building, or buried back of two inches of concrete or brick within a wall, are considered as lying outside of the building. These requirements do not apply to factory yards and factory buildings under single occupancy or management.

#### 18. Table of Allowable Carrying Capacities of Wires.

(For construction rules see Nos. 49 to 57.)

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

For insulated aluminum wire the safe carrying capacity is eighty-four per cent of that given in the following tables for copper wire with the same kind of insulation.

| B. & S. Gauge Number | Diameter of Solid Wire in Mils | Area in Circular Mils | Table A.                  | Table B.                 |
|----------------------|--------------------------------|-----------------------|---------------------------|--------------------------|
|                      |                                |                       | Rubber Insulation Amperes | Other Insulation Amperes |
| 18                   | 40.3                           | 1,624                 | 3                         | 5                        |
| 16                   | 50.8                           | 2,583                 | 6                         | 10                       |
| 14                   | 64.1                           | 4,107                 | 15                        | 20                       |
| 12                   | 80.8                           | 6,530                 | 20                        | 25                       |
| 10                   | 101.9                          | 10,380                | 25                        | 30                       |
| 8                    | 128.5                          | 16,510                | 35                        | 50                       |
| 6                    | 162.0                          | 26,250                | 50                        | 70                       |
| 5                    | 181.9                          | 33,100                | 55                        | 80                       |
| 4                    | 204.3                          | 41,740                | 70                        | 90                       |
| 3                    | 229.4                          | 52,630                | 80                        | 100                      |
| 2                    | 257.6                          | 66,370                | 90                        | 125                      |
| 1                    | 289.3                          | 83,690                | 100                       | 150                      |
| 0                    | 325                            | 105,500               | 125                       | 200                      |
| 00                   | 364.8                          | 133,100               | 150                       | 225                      |
| 000                  | 409.6                          | 167,800               | 175                       | 275                      |
|                      |                                | 200,000               | 200                       | 300                      |
| 0000                 | 460                            | 211,600               | 225                       | 325                      |
|                      |                                | 300,000               | 275                       | 400                      |
|                      |                                | 400,000               | 325                       | 500                      |
|                      |                                | 500,000               | 400                       | 600                      |
|                      |                                | 600,000               | 450                       | 680                      |
|                      |                                | 700,000               | 500                       | 760                      |
|                      |                                | 800,000               | 550                       | 840                      |
|                      |                                | 900,000               | 600                       | 920                      |
|                      |                                | 1,000,000             | 650                       | 1,000                    |
|                      |                                | 1,100,000             | 690                       | 1,080                    |
|                      |                                | 1,200,000             | 730                       | 1,150                    |
|                      |                                | 1,300,000             | 770                       | 1,220                    |
|                      |                                | 1,400,000             | 810                       | 1,290                    |
|                      |                                | 1,500,000             | 850                       | 1,360                    |
|                      |                                | 1,600,000             | 890                       | 1,430                    |
|                      |                                | 1,700,000             | 930                       | 1,490                    |
|                      |                                | 1,800,000             | 970                       | 1,550                    |
|                      |                                | 1,900,000             | 1,010                     | 1,610                    |
|                      |                                | 2,000,000             | 1,050                     | 1,670                    |

1 Mil = 0.001 inch.

#### 19. Switches, Cut-outs, Circuit-breakers, Etc.

a. On constant potential circuits, all service switches and all switches controlling circuits supplying current to motors or heating devices, and all fuses, unless otherwise provided (for exceptions as to switches see Nos. 8 c, 24 a and c, 25 a and 43 c; for exceptions as to cut-outs see No. 23 a and b), must be so arranged that the fuses will protect and the opening of the switch will disconnect all of the wires, that is, in the two-wire system the two wires, and the three-wire system the three wires, must be protected by the fuses and disconnected by the operation of the switch.

When installed without other automatic overload protective devices automatic overload circuit breakers must have the poles and trip coils so arranged as to afford complete protection against overloads and short circuits. In two or three-phase three-wire circuits and two-phase four-wire circuits there must be a trip-coil in each of two phases, and in four-wire three-phase circuits there must be a trip-coil in each phase. If a circuit-breaker is also used in place of the switch it

must be so arranged that no one pole can be opened manually without disconnecting all the wires.

The above rules do not apply to grounded return circuits of electric railway systems.

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

Where the occupancy of the building is such that switches, cut-outs, etc., cannot be located so as not to be exposed as above, they must be mounted in approved cut-out boxes or cabinets, except oil switches, circuit-breakers and similar devices which have approved casings.

Cabinets and cut-out boxes must be of metal when used with metal conduit, armored cable or metal raceway systems (for exceptions see No. 40 c and 41 e).

c. Must, when located where exposed to moisture, as in basements and similar places, be mounted in approved cut-out boxes or cabinets, and when located in wet places or outside of buildings must be mounted in approved "weatherproof" cut-out boxes or cabinets.

d. Time switches, sign flashers and similar appliances must be of approved design and enclosed in approved cabinets, except sign flashers mounted as described in No. 83 b.

e. Must have the spacing within cabinets or cut-out boxes between the walls of the cabinet or cut-out box and current-carrying parts of devices as specified in No. 70.

## CONSTANT-CURRENT SYSTEMS

### PRINCIPALLY SERIES ARC-LIGHTING

Constant current systems will not be allowed inside buildings except by special permission.

#### 20. Wires.

(See also Nos. 16, 17, 18 and 44. For construction rules see Nos. 49 and 50.)

a. Must have an approved rubber insulating covering.

b. Must be arranged to enter and leave the building through an approved double-contact service switch, mounted in a non-combustible case, kept free from moisture, and easy of access to police or firemen.

Switches must 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 whether the current be "on" or "off."

c. Must always be in plain sight, and never encased, except when required by this Department.

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 or in cut-out 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 under side of a wooden strip not less than one-half an inch in thickness. Instead of the running-boards, guard strips on each side of and close to the wires will be accepted.

These strips to be not less than seven-eighths of an inch in thickness and at least as high as the insulators.

#### 21. Series Arc Lamps.

a. Must be carefully isolated from inflammable material.

b. Must be provided at all times with a glass globe surrounding the arc, and securely fastened upon a closed base. Broken or cracked globes must not 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, when readily inflammable material is in the vicinity of the lamps, to prevent escape of sparks or carbon or melted copper.

Outside arc lamps must be suspended at least eight feet above sidewalks. Inside arc lamps must be placed out of reach or suitably protected.

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

"Enclosed arc" lamps, having tight inner globes, may be used, and the requirements of Sections b and c above would, of course, not apply to them.

d. Where hanger-boards are not used, lamps must be hung from insulating supports other than their conductors.

e. Lamps when arranged to be raised and lowered either for carboning or other purposes, shall be connected up with stranded conductors from the last point of support to the lamp, when such conductor is larger than No. 14 B. & S. gauge.

#### 22. Incandescent Lamps in Series Circuits.

a. Must have the conductors installed as required in No. 20, and each lamp must be provided with an automatic cut-out.

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

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

d. Must not under any circumstances be attached to gas fixtures.

## CONSTANT-POTENTIAL SYSTEMS.

### GENERAL RULES—ALL VOLTAGES.

#### 23. Automatic Cut-outs (Fuses and Circuit-breakers).

(See also No. 19. For construction rules see Nos. 66 and 67.)

a. Must be placed in all underground service wires, either overhead or underground, in the nearest accessible place to the point where they enter the building and inside the walls, and arranged to cut off the entire current from the building. Departure from this rule may be authorized only under special permission in writing.

Where service switch, service fuses and meter are combined in an approved self-contained device or compact combination of such devices having no exposed wiring or live parts and no parts unprotected by fuses, except potential coils of the meter, such potential coils may be connected on the supply side of the service fuses.

In risks having private plants, the yard wires running from building to building are not considered as service wires, so that cut-outs would not be required where the wires enter buildings, provided that the next fuse back is small enough to properly protect the wires inside the building in question.

b. Must be placed at every point where a change is made in the size of wire [unless the cut-out in the larger wire will protect the smaller (see No. 18)].

Must not be placed in any permanently grounded wire, except as called for in Section d.

c. Must be in plain sight, or enclosed in an approved cabinet, and readily accessible. They must not be placed in the canopies or shells of fixtures.

Link fuses may be used only when mounted on approved bases which, except on switchboards must be mounted in approved cut-out boxes or cabinets. A space of at least two inches must be provided between the open-link fuses and metal, or metal lined walls or metal, metal lined or glass paneled doors of cabinet or cut-out boxes.

d. Must be so placed that no set of small motors, small heating devices or incandescent lamps, whether grouped on one fixture or on several fixtures or pendants (nor more than 16 medium size or 25 candelabra size sockets or lamp receptacles) requiring more than 660 watts, will be dependent upon one cut-out.

By special permission, in cases where wiring equal in size and insulation to No. 14 B. & S. gage approved rubber-covered wire is carried direct into keyless sockets or receptacles, and where the location of sockets and receptacles is such as to render unlikely the attachment of flexible cords thereto, the circuits may be so arranged that not more than 1,320 watts (or thirty-two sockets or receptacles) will be dependent upon the final cut-out.

Except for signs and outline lighting, receptacles for attachment plugs, sockets and lamp receptacles will be considered as requiring not less than 40 watts each, if of the medium size, or 25 watts each if of the candelabra size.

All branches or taps from any three-wire system which are directly connected to lamp sockets or other translating devices must be run as two-wire circuits. All wires of all branch or tap circuits which are directly connected to lamp sockets or other translating devices must be protected by proper fuses.

The fuses in the branch cut-outs protecting circuits of 660 watts or less shall not have a rated capacity greater than that given in the following table:—

|                        |            |
|------------------------|------------|
| 125 volts or less..... | 10 amperes |
| 126 to 250 volts.....  | 6 amperes  |

When 1,320 watts are dependent upon one fusible cut-out, as is allowed in theatre wiring, outline lighting, signs and large chandeliers, the fuses may be in accordance with the following table:—

|                        |            |
|------------------------|------------|
| 125 volts or less..... | 20 amperes |
| 126 to 250 volts.....  | 10 amperes |

Fused rosettes may be used only for open work in large mills. Approved link fused rosettes may be used at a voltage of not over 125 and approved enclosed fused rosettes at a voltage of not over 250, the fuse in the rosettes not to exceed 3 amperes, and a fuse of over 25 amperes must not be used in the branch circuit.

e. The rated capacity of fuses must not exceed the allowable carrying capacity of the wire as given in No. 18. Circuit breakers must not be set more than 30 per cent above allowable carrying capacity of the wire, unless a fusible cut-out is also installed on the circuit. Where a rubber-covered conductor carries the current of only one A. C. motor of a type requiring large starting current, it may be protected by a fuse or an automatic circuit breaker without time limit device, rated in accordance with Table B of No. 18. The rated continuous current capacity of a time limit circuit breaker protecting a motor of the above type need not be greater than 110 per cent of the motor current rating, provided the time limit device is capable of preventing the breaker opening during the starting period.

In the great majority of cases where A. C. motors of the above type are started by means of auto-starters the current-carrying capacity of wires meeting the rule will not exceed the following percentages of the full load currents of the motors:—

| Rated Full Load Current | Percentage |
|-------------------------|------------|
| 0-30 amperes            | 250        |
| Above 30 amperes        | 200        |

For the protection of wires having safe carrying capacities exceeding the rated capacity of the largest approved enclosed type fuses, approved enclosed fuses arranged in multiple may be used, provided as few fuses as possible are used and the fuses are of equal capacity and provided the cut-out terminals are mounted on a single continuous pair of substantial bus bars. The total capacity of the fuses should not exceed the safe carrying capacity of the wires. This does not apply to motor circuits.

Fixture wire or flexible cord of No. 18 B. & S. gage will be considered as properly protected by 10 ampere fuses.

f. Each conductor of motor circuits, except on main switchboard or when otherwise sub-

ject to competent supervision, must be protected by an approved fuse, whether automatic overload circuit breakers are installed or not. Single phase motors may have one side protected by an approved automatic overload circuit breaker only, if the other side is protected by an approved fuse.

Circuit breakers will be approved for circuits having a maximum capacity greater than that for which approved enclosed fuses are rated.

#### 24. Switches.

(See No. 19. For construction of Switches see No. 65.)

a. Must be placed on all service wires either overhead or underground in the nearest readily accessible place to the point where the wires enter the building.

Service switches must be arranged to cut off the entire current from all circuits and devices including meters except as provided in the following: Where service fuses and meter are combined in an approved single self-contained unit device having no exposed wiring or live parts and no parts not protected by the fuses, the switch may be so arranged or installed that it will not disconnect the meter from the supply line provided it does disconnect all lines of the supplied house circuits.

Service switches must indicate plainly whether they are open or closed.

Departure from the provisions of the above rule may be authorized only under special permission in writing.

In risks having private plants the yard wires running from building to building are not considered as service wires, so that switches would not be required in each building if there are other switches conveniently located on the mains or if the generators are near at hand.

With 3-wire direct-current or single-phase systems with grounded neutral, the service switch may be so designed as to permit either outside wire to be opened independently of the other, but the design must be such that the neutral cannot be opened without opening both outside wires.

b. Must always be placed in dry, accessible places, and be grouped as far as possible. (See No. 19 c.) Single-throw knife switches must be so placed that gravity will not tend to close them. Double-throw knife switches may be mounted so that the throw will be either vertical or horizontal as preferred, but if the throw be vertical a locking device must be provided, so constructed as to insure the blades remaining in the open position when so set.

When practicable switches must be so wired that blades will be "dead" when switch is open.

Up to 250 volts and thirty amperes, approved indicating snap switches are suggested in preference to knife switches on lighting circuits.

c. Single-pole switches must never be used as service switches, except as permitted in Section a, nor for the control of outdoor signs or circuits located in damp places, nor placed in the neutral wire of a three-wire

system, except in the two-wire branch or tap circuit supplying not more than 660 watts.

This, of course, does not apply to the grounded circuits of Street Railway systems.

Three-way switches are considered as single pole switches.

d. Where flush switches or receptacles are used, whether with conduit systems or not, they must be enclosed in an approved box constructed of iron or steel, in addition to the porcelain enclosure of the switch or receptacle.

At floor outlets, attachment plugs and receptacles must be enclosed in approved floor outlet boxes especially designed for this purpose. Departure from this rule may be authorized only under special permission in writing in cases where attachment plugs and receptacles are not subject to mechanical injury and the presence of moisture is not probable.

e. Must be supported at outlets when possible by  $\frac{1}{8}$ -inch blocks fastened between studs flush with back of lath except when approved fittings or outlet boxes which will give proper support are used. When this cannot be done base blocks not less than  $\frac{3}{4}$ -inch in thickness securely screwed to the lathing must be provided.

f. Sub-bases of non-combustible, non-absorptive, insulating material, which will separate the wires at least one-half inch from the surface wired over, must be installed under all snap switches used in exposed knob and cleat work. Sub-bases must also be used in molding work, but they may be made of hardwood or they may be omitted if the switch is approved for mounting directly on the molding.

#### 25. Heating Devices.

a. Each heater of more than six (6) amperes or 660 watts capacity must be protected by a cut-out. Heaters of six (6) amperes or 660 watts capacity, or less, may be grouped under the protection of a single set of fuses, provided the rated capacity of the fuses does not exceed ten (10) amperes, or may be connected individually to lighting circuits when the normal load in use on the circuit-at any time will not exceed 660 watts. Subdivided circuits of a heater need not be separately fused.

Each heater of more than six (6) amperes or 660 watts capacity and each group of heaters not exceeding six (6) amperes or 660 watts capacity must be controlled by a switch plainly indicating whether "on" or "off," located within sight of the heater arranged to cut off all current from the heater. Where the capacity of the heater does not exceed fifteen (15) amperes or 1,650 watts, an approved plug connector may be employed in lieu of a switch. Switches controlling subdivided circuits of a heater are not considered to take the place of the main switch called for by this paragraph.

The single pole switches on the individual units of electric ranges, etc., are not to be considered as taking the place of the switch required by this rule.

b. Flexible conductors for smoothing irons and sadirons, and for all devices requiring

over 250 watts, must have an approved insulation and covering complying with the requirements of No. 51f.

c. With portable heating devices, approved plug connectors must be used, so arranged that the plug may be pulled out to open the circuit without leaving any live parts so exposed as to render likely accidental contact therewith. The connector may be located at either end of the flexible conductor or inserted in the conductor itself.

d. Smoothing irons, sadirons and other heating devices that are intended to be applied to combustible articles, must be provided with approved stands.

It is strongly recommended that each such heating device or group of devices be used with approved signal or with an approved protective device.

e. Stationary heaters, such as radiators, ranges, plate warmers, etc., must be so located as to furnish ample protection between the device and surrounding combustible material.

The metal frame of such stationary heaters, etc., should preferably be grounded and if grounded must be as provided in No. 15A. When grounding is impracticable special permission, in writing, may be given, in which case the frame must be permanently and effectively insulated.

f. Must each be provided with a nameplate, giving the maker's name and the normal capacity in volts and amperes, or in volts and watts.

## LOW-POTENTIAL SYSTEMS.

### 550 VOLTS OR LESS.

*Any circuit attached to any transforming device, machine, or combination of machines, which develops a difference of potential between any two wires or between any wire and the ground of not over 550 volts, shall be considered as a low-potential circuit, and as coming under this class. The primary circuit not to exceed a potential of 3,500 volts, unless the primary wires are installed in accordance with the requirements as given in No. 13, or are underground. For 550 volt motor equipments a margin of ten per cent above 550 volt limit will be allowed at the generator or transformer.*

## 26. Wires.

### GENERAL RULES

(See also Nos. 16, 17, 18, 20 and 27. For construction rules see Nos. 49 to 57.)

a. (After Jan. 1, 1919.) The neutral conductor on all three-wire circuits and one conductor on all two-wire circuits must have an identifying insulating covering, readily distinguishing it from other wires. This wire must be run without transposition throughout the entire installation and properly connected at all fittings to properly identified terminals in order to preserve its continuity.

When one of the circuit wires is to be grounded, the ground connection must be made to this identified wire and as prescribed in Nos. 15 and 15A.

b. When entering cabinets, cut-out boxes or junction boxes, except where they are in conduit, armored cable or metal raceways, they must be protected by non-combustible,

non-absorptive insulating bushings, which fit tightly the holes in the box or cabinet and are well secured in place. The wires should completely fill the holes in the bushings, so as to keep out dust, tape being used to build up the wires if necessary. For concealed knob and tube work, or for open work in dry places, approved flexible tubing will be accepted in lieu of bushings, providing it extends from the last porcelain support into a wooden cabinet, or is secured to a metal cabinet, cut-out box, junction or switch-box by an approved fitting.

c. Must not be laid in plaster, cement or similar finish, and must never be fastened with staples.

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, where exposed to mechanical injury, be suitably protected. When crossing floor timbers in cellars or rooms where they might be exposed to injury wires must be installed in approved conduit or armored cable or be otherwise properly guarded. Where running boards are acceptable they must be not less than one-half inch in thickness and not less than three inches in width; where guard strips are acceptable these must not be less than seven-eighths inch in thickness and at least as high as the insulators and must be placed on each side of and close to the wires.

Protection on side walls must extend not less than seven feet from the floor and must consist of substantial boxing, retaining an air space of one inch around the conductors, closed at the top (the wires passing through bushed holes) or approved metal conduit or pipe of equivalent strength.

When metal conduit or pipe is used, the insulation of each wire must be reinforced by approved flexible tubing extending from the insulator next below the pipe to the one next above it, unless the conduit is installed according to No. 28 (Sections c and f excepted), and the wire is approved for conduit use. The two or more wires of a circuit each with its flexible tubing (when required), if carrying alternating current must, or if direct current may, be placed within the same pipe.

In damp places the wooden boxing may be preferable because of the precautions which would be necessary to secure proper insulation if the pipe were used. With this exception, however, iron piping is considered preferable to the wooden boxing, and its use is strongly urged. It is especially suitable for the protection of wires near belts, pulleys, etc.

f. When run in unfinished attics, or roof spaces, will be considered as concealed, and when run in close proximity to water tanks or pipes, will be considered as exposed to moisture. In unfinished attics, or roof spaces, wires to be considered as exposed to mechanical injury, and must not be run on knobs on upper edge of joists, except that in inaccessible roof spaces where wires are run across joists, they may be supported on knobs on the upper edge of each joist,

**For Open Work.***In dry places.*

g. Must have an *approved* rubber (Type Letter R. for wires smaller than No. 6 B. & S. gage and Type Letter R. D. for wires No. 6 and larger), slow-burning weatherproof (Type Letter S. B. W.), or slow-burning insulation (Type Letter S. B.)

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

| Voltage    | Distance from Surface | Distance between Wires. |
|------------|-----------------------|-------------------------|
| 0 to 300   | 1/2 inch              | 2 1/2 inch              |
| 301 to 550 | 1 inch                | 4 inch                  |

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 must be shortened. In buildings of mill construction, mains of not less than No. 8 B. & S. gage, where not liable to be disturbed, may be separated about six inches, and run from timber to timber, not breaking around, and may be supported at each timber only.

Must not be "dead-ended" at a rosette, socket or receptacle unless the last support is within twelve inches of the same.

*In damp places, or buildings specially subject to moisture or to acid or other fumes liable to injure the wires or their insulation.*

i. Must have an *approved* insulating covering.

For protection against water, rubber insulation must be used. For protection against corrosive vapors, either weather-proof or rubber insulation must be used.

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 must be kept apart at least two and one-half inches for voltages up to 300, and four inches for higher voltages.

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 must be shortened. In buildings of mill construction, mains of not less than No. 8 B. & S. gage, where not liable to be disturbed, may be separated about 6 inches, and run from timber to timber, not breaking around, and may be supported at each timber only.

**For Surface Wiring Raceways.**

(Wooden and Metal. See No. 29. For construction of Raceways see No. 60.)

k. Must have an *approved* rubber insulating covering (Type Letter R. for wires smaller than No. 6 B. & S. gage and Type Letter R. D. for wires No. 6 and larger), and must be in continuous lengths from outlet to outlet, or from fitting to fitting, no joints or taps

to be made in the raceway. Where branch taps are necessary in raceway work *approved* fittings for this purpose must be used.

l. Must never be placed in either metal or wooden raceways in damp locations; must never be placed in either metal or wooden raceways in concealed locations or where the difference of potential between any two wires in the same system is over 300 volts. When the electrical construction is being carried out in metal raceways, permission will be given to extend these raceways through walls and partitions if the raceways are in continuous lengths where passing through the walls and partitions. Not more than four No. 14 B. & S. gage rubber covered wires, and no single circuit of more than 1,320 watts shall be used in metal raceways.

m. Must for alternating current systems if in metal raceways have the two or more wires of a circuit installed in the same raceway.

It is suggested 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 if the wires are in separate raceways.

**For Conduit Work.**

n. Must have an *approved* rubber insulating covering, and within the conduit tubing must be without splices or taps. Must be double braided (Type Letters R. D.) for twin, twisted pair or multiple conductor cables and for all single conductors of No. 6 B. & S. gage and larger.

Slow burning insulation may, however, be used in permanently dry locations where excessive temperatures are present, provided special permission in writing be given in advance.

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

Conductors in vertical conduit risers must be supported within the conduit system in accordance with the following table:

No. 14 to 0 inclusive every 100 feet.

No. 00 to 0000 inclusive every 80 feet.

Above 0000 to 350,000 C. M. inclusive every 60 feet.

Above 350,000 C. M. to 500,000 C. M. inclusive every 50 feet.

Above 500,000 C. M. to 750,000 C. M. inclusive every 40 feet.

Above 750,000 C. M. every 35 feet.

The following methods of supporting cables are recommended:

1. *Approved* clamping devices constructed of or employing insulating wedges inserted in the ends of conduits.

2. Junction boxes may be inserted in the conduit system at the required intervals, in which insulating supports of *approved* type must be installed and secured in a satisfactory manner so as to withstand the weight of the conductors attached thereto, the boxes to be provided with proper covers.

3. Cables may be supported in *approved* junction boxes on two or more insulating supports so placed that the conductors will be deflected at an angle of not less

than 90 degrees, and carried a distance of not less than twice the diameter of the cable from its vertical position. Cables so suspended may be additionally secured to these insulators by tie wires.

Other methods may be used if specially approved.

Conductors No. 2 B. & S. gage, or larger, must not be deflected where they enter or leave the cabinet except that conductors of No. 2 B. & S. gage to 250,000 C. M. inclusive if brought into the cabinet, cut-out box, junction or pull box opposite to the panel lugs in which they terminate may be deflected sufficiently to permit their attachment to these lugs provided the gutter of the cabinet is not less than 4 inches in width.

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

It is suggested 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 if the wires are in separate conduits.

Except in the case of stage pocket and border circuits the same conduit must not contain more than four two-wire, or three three-wire circuits of the same system, except by special permission, and must never contain circuits of different systems.

#### For Concealed "Knob and Tube" Work.

*q.* Must have an approved rubber insulating covering (Type Letter R. for wires smaller than No. 6 B. & S. gage and Type Letter R. D. for wires No. 6 and larger).

*r.* Must be rigidly supported on non-combustible, non-absorptive insulators which separate the wire at least one inch from the surface wired over. Should preferably be run singly on separate timbers, or studding, and must be kept at least five inches apart.

Must be separated from contact with the walls, floor timbers and partitions through which they may pass by non-combustible, non-absorptive, insulating tubes, such as glass or porcelain. Wires passing through cross timbers in plastered partitions must be protected by an additional tube extending at least four inches above the timber.

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 must be shortened.

At distributing centers, meters, outlets, switches or other places where space is limited, and the five-inch separation cannot be maintained, each wire must be separately encased in a continuous length of approved flexible tubing.

*s.* When in a concealed knob and tube system, it is impracticable to place the whole of a circuit on non-combustible supports of glass or porcelain, that portion of the circuit which cannot be so supported must be installed with approved metal conduit, or approved armored cable, except that if the difference of potential between the wires is not over 300 volts, and if the wires are not exposed to moisture, they may be fished if separately encased in approved flexible tub-

ing, extending in continuous lengths from porcelain support to porcelain support, from porcelain support to outlet, or from outlet to outlet.

*t.* When using either conduit or armored cable in mixed concealed knob and tube work, the requirements for conduit work or armored cable work must be complied with as the case may be except that approved fittings having a separate bushed hole for each conductor may be used for terminating the conduit or armored cable where wires pass from the conduit or cable without splice, joint or tap.

*u.* Must at all outlets, except where conduit is used, be protected by approved flexible tubing, extending in continuous lengths from the last porcelain support to at least one inch beyond the outlet. In the case of combination gas and electric outlets the tubes on the wires must extend at least flush with the outlet ends of gas caps, and if box or plate is used, gas pipes must be securely fastened into the outlet box or plate to secure good electrical connection.

When the surface at any outlet is broken, it must be repaired so as to leave no holes or open spaces at such outlet.

It is suggested that approved outlet boxes or plates be installed at all outlets in concealed "knob and tube" work, the wires to be protected by approved flexible tubing, extending in continuous lengths from the last porcelain support into the box.

For concealed work in walls and ceilings composed of plaster on wooden joist or stud construction, outlet boxes or plates if used, and also cabinets or switch boxes must be so installed that the front edge will not be more than one-fourth inch back of the finished surface of the plaster, and if this surface is broken or incomplete it shall be repaired so that it will not show any gaps or open spaces around the edges of the outlet box or plate if used, or of the cabinet. On wooden walls or ceilings, outlet boxes or plates, and cabinets or switch boxes must be so installed that the front edge will either be flush with the finished surface or project therefrom.

#### 27. Armored Cables.

(See also No. 26 s. For construction of Armored Cables see No. 54.)

*a.* Must be continuous from outlet to outlet or to junction boxes or cabinets, and the armor of the cable must properly enter and be secured to all fittings, and the entire system must be mechanically secured in position.

In case of service connections and main runs, this involves running such armored cable continuously into a main cut-out cabinet or gutter surrounding the panel board, as the case may be.

*b.* Must be equipped at every outlet with an approved outlet box or plate, as required in conduit work.

Outlet plates must not be used where it is practicable to install outlet boxes.

For concealed work in walls and ceilings composed of plaster on wooden joist or stud construction, outlet boxes or plates and also cut-out cabinets must be so installed that the front edge will not be more than one-fourth

inch back of the finished surface of the plaster, and if this surface is broken or incomplete it shall be repaired so that it will not show any gaps or open spaces around the edges of the outlet box or plate or of the cut-out cabinet. On wooden walls or ceilings, outlet boxes or plates and cut-out cabinets must be so installed that the front edge will either be flush with the finished surface or project therefrom. This will not apply to concealed work in walls or ceilings composed of concrete, tile or other non-combustible material.

In buildings already constructed where the conditions are such that neither outlet box nor plate can be installed, these appliances may be omitted by special permission, provided the armored cable is firmly and rigidly secured in place.

At exposed ends of armored cable (except fixture outlets) where the wires pass from the armored cable system without splice, joint or tap an *approved* fitting having a separate bushed hole for each conductor must be used.

c. Must have the metal armor of cables grounded as required in No. 15A.

d. When installed in so-called fireproof buildings in course of construction or afterwards if exposed to moisture, or where it is exposed to the weather, or in damp places, such as breweries, stables, etc., the cable must have a lead covering placed between the outer braid of the conductors and the steel armor.

The lead covering is not to be required when the cable is run against brick walls or laid in ordinary plaster walls unless same are continuously damp.

e. Where entering junction boxes, and at all other outlets, etc., must be provided with *approved* terminal fittings which will protect the insulation of the conductors from abrasion, unless such protection is afforded by the junction or outlet boxes themselves.

f. Junction boxes must always be installed in such a manner as to be accessible except as provided in No. 26 t.

g. For alternating current systems must have the two or more conductors of the circuit enclosed in one metal armor.

h. All bends must be so made that the armor of the cable will not be injured. The radius of the curve of the inner edge of any bend not to be less than  $1\frac{1}{2}$  inches.

## 28. Interior Conduits.

(See also No. 26 n to p. For construction of Conduit see No. 58, and for construction of Outlet, Junction and Flush Switch Boxes see No. 59.)

a. No conduit smaller than one-half inch electrical trade size shall be used.

b. Must be continuous from outlet to outlet or to junction boxes or cabinets, and the conduit must properly enter, and be secured to all fittings and the entire system must be mechanically secured in position.

In case of service connections and main runs, this involves running each conduit continuously into a main cut-out cabinet or gutter surrounding the panel board, as the case may be.

Departure from this rule may be authorized in case of underground services by special permission.

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 or plate. At exposed ends of conduit (but not at fixture outlets) where wires pass from the conduit system without splice, joint or tap, an *approved* fitting having separately bushed holes for each conductor must be used. Departure from this rule may be authorized by special permission.

Outlet plates must not be used where it is practicable to install outlet boxes.

For concealed work in walls and ceilings composed of plaster on wooden joists or stud construction, outlet boxes or plates and also cut-out cabinets must be so installed that the front edge will not be more than one-fourth inch back of the finished surface of the plaster, and if this surface is broken or incomplete it shall be repaired so that it will not show any gaps or open spaces around the edges of the outlet box or plate or of the cut-out cabinet. On wooden walls or ceilings, outlet boxes or plates and cut-out cabinets must be so installed that the front edge will either be flush with the finished surface or project therefrom. This will not apply to concealed work in walls or ceilings composed of concrete, tile or other non-combustible material.

In buildings already constructed where the conditions are such that neither outlet box nor plate can be installed, these appliances may be omitted, providing the conduit ends are bushed and secured.

It is suggested that outlet boxes and fittings having conductive coatings be used in order to secure better electrical contact at all points throughout the conduit system.

e. Metal conduits where they enter junction boxes, and at all other outlets, etc., must be provided with *approved* bushings or fastening plates fitted so as to protect wire from abrasion, except when such protection is obtained by the use of *approved* nipples, properly fitted in boxes or devices.

f. Must have the metal of the conduit grounded as required in No. 15A.

g. Junction boxes must always be installed in such a manner as to be accessible except as provided for in No. 26 t. Such boxes are considered to be accessible when installed in an attic that has sufficient headroom, but which is reached only by a portable ladder and permanent hatch.

h. 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 outlets not being counted.

4. SIZE OF CONDUITS FOR THE INSTALLATION OF WIRES AND CABLES.  
NUMBER OF CONDUCTORS

| Size B. & S. | One conductor in a conduit. Size conduit, inches. | Two conductors in a conduit. Size conduit, inches. | Three conductors in a conduit. Size conduit, inches. | Four conductors in a conduit. Size conduit, inches. |
|--------------|---|--|--|---|
|              | Electrical Trade Size                             | Electrical Trade Size                              | Electrical Trade Size                                | Electrical Trade Size                               |
| 14           | 1 $\frac{1}{2}$                                   | 1 $\frac{1}{2}$                                    | 1 $\frac{1}{2}$                                      | 1 $\frac{3}{4}$                                     |
| 12           | 1 $\frac{1}{2}$                                   | 1 $\frac{1}{2}$                                    | 1 $\frac{1}{2}$                                      | 1 $\frac{3}{4}$                                     |
| 10           | 1 $\frac{1}{2}$                                   | 1 $\frac{1}{2}$                                    | 1 $\frac{1}{2}$                                      | 1   |
| 8            | 1 $\frac{1}{2}$                                   | 1  | 1  | 1   |
| 6            | 1 $\frac{1}{2}$                                   | 1  | 1 $\frac{1}{4}$                                      | 1 $\frac{1}{4}$                                     |
| 5            | 1 $\frac{1}{2}$                                   | 1 $\frac{1}{4}$                                    | 1 $\frac{1}{4}$                                      | 1 $\frac{1}{4}$                                     |
| 4            | 1 $\frac{1}{2}$                                   | 1 $\frac{1}{4}$                                    | 1 $\frac{1}{4}$                                      | 1 $\frac{1}{4}$                                     |
| 3            | 1 $\frac{1}{2}$                                   | 1 $\frac{1}{4}$                                    | 1 $\frac{1}{4}$                                      | 1 $\frac{1}{4}$                                     |
| 2            | 1 $\frac{1}{2}$                                   | 1 $\frac{1}{4}$                                    | 1 $\frac{1}{4}$                                      | 1 $\frac{1}{4}$                                     |
| 1            | 1 $\frac{1}{2}$                                   | 1 $\frac{1}{4}$                                    | 1 $\frac{1}{4}$                                      | 1 $\frac{1}{4}$                                     |
| 0            | 1   | 1 $\frac{1}{2}$                                    | 2  | 2   |
| 00           | 1   | 2  | 2  | 2 $\frac{1}{4}$                                     |
| 000          | 1   | 2  | 2  | 2 $\frac{1}{2}$                                     |
| 0000         | 1 $\frac{1}{4}$                                   | 2  | 2 $\frac{1}{2}$                                      | 2 $\frac{1}{2}$                                     |
| CM           |   |  |  |   |
| 200000       | 1 $\frac{1}{4}$                                   | 2  | 2 $\frac{1}{4}$                                      | 2 $\frac{1}{2}$                                     |
| 250000       | 1 $\frac{1}{4}$                                   | 2 $\frac{1}{4}$                                    | 2 $\frac{1}{4}$                                      | 3   |
| 300000       | 1 $\frac{1}{4}$                                   | 2 $\frac{1}{2}$                                    | 2 $\frac{1}{4}$                                      | 3   |
| 400000       | 1 $\frac{1}{4}$                                   | 3  | 3  | 3 $\frac{1}{2}$                                     |
| 500000       | 1 $\frac{1}{4}$                                   | 3  | 3  | 3 $\frac{1}{2}$                                     |
| 600000       | 1 $\frac{1}{4}$                                   | 3  | 3 $\frac{1}{4}$                                      | 3 $\frac{1}{2}$                                     |
| 700000       | 2   | 3 $\frac{1}{2}$                                    | 3 $\frac{1}{2}$                                      | 4   |
| 800000       | 2   | 3 $\frac{1}{2}$                                    | 4  | 4   |
| 900000       | 2   | 3 $\frac{1}{2}$                                    | 4  | 4   |
| 1000000      | 2   | 4  | 4  | 4   |
| 1250000      | 2 $\frac{1}{4}$                                   | 4 $\frac{1}{2}$                                    | 4 $\frac{1}{2}$                                      | 5   |
| 1500000      | 2 $\frac{1}{4}$                                   | 4 $\frac{1}{2}$                                    | 5  | 5   |
| 1750000      | 3   | 5  | 5  | 5   |
| 2000000      | 3   | 5  | 6  | 6   |

For sizes not greater than No. 10 B. & S. gage, one more conductor than permitted by the above table may be installed in the specified conduit, provided the conduit is not longer than 30 feet, and has not more than the equivalent of two quarter bends from outlet, the bends at the outlets not being counted.

3-CONDUCTOR CONVERTIBLE SYSTEM.

| Size of Conductors in one Conduit |                          | Size Conduit, Inches  |
|-----------------------------------|--------------------------|-----------------------|
| 2-conductors Size B. & S.         | 1-conductor Size B. & S. | Electrical Trade Size |
| 14                                | 10                       | 3 $\frac{1}{4}$       |
| 12                                | 8                        | 3 $\frac{1}{4}$       |
| 10                                | 6                        | 1                     |
| 8                                 | 4                        | 1                     |
| 6                                 | 2                        | 1 $\frac{1}{4}$       |
| 5                                 | 1                        | 1 $\frac{1}{4}$       |
| 4                                 | 0                        | 1 $\frac{1}{2}$       |
| 3                                 | 00                       | 1 $\frac{1}{2}$       |
| 2                                 | 000                      | 1 $\frac{1}{2}$       |
| 1                                 | 0000                     | 2                     |
| 0                                 | 250000                   | 2                     |
| 00                                | 350000                   | 2 $\frac{1}{4}$       |
| 000                               | 400000                   | 2 $\frac{1}{2}$       |
| 0000                              | 550000                   | 3                     |
| 250000                            | 600000                   | 3                     |
| 300000                            | 800000                   | 3                     |
| 400000                            | 1000000                  | 3 $\frac{1}{2}$       |
| 500000                            | 1250000                  | 4                     |
| 600000                            | 1500000                  | 4                     |
| 700000                            | 1750000                  | 4 $\frac{1}{2}$       |
| 800000                            | 2000000                  | 4 $\frac{1}{2}$       |

SINGLE-CONDUCTOR COMBINATION.

NOTE—Where special permission has been given in accordance with No. 26 p the following table to apply.

| No. of Wires              | Size Conduit, in. Electrical Trade Size |
|---------------------------|---|
| 10 No. 14 R.C. solid..... | 1                                       |
| 18 No. 14 R.C. solid..... | 1 $\frac{1}{4}$                         |
| 24 No. 14 R.C. solid..... | 1 $\frac{1}{2}$                         |
| 40 No. 14 R.C. solid..... | 2                                       |
| 74 No. 14 R.C. solid..... | 2 $\frac{1}{2}$                         |
| 90 No. 14 R.C. solid..... | 3                                       |

29. Metal Raceways for Surface Wiring.

(See also No. 26 k to m. For construction of Raceways see No. 60.)

a. Metal raceways may be used for exposed work only.

b. Must be continuous from outlet to outlet, to junction boxes, or approved fittings designed especially for use with metal raceways, and must at all outlets be provided with approved terminal fittings which will protect the insulation of conductors from abrasion, unless such protection is afforded by the construction of the boxes or fittings.

c. Such raceway where passing through a floor must be carried through an iron pipe extending from the ceiling below to a point five feet above the floor which will serve as an additional mechanical protection and exclude the presence of moisture often prevalent in such locations.

Where the mechanical strength of the raceway itself is adequate, this ruling may be modified to require the protecting piping from the ceiling below to a point at least three inches above the flooring.

Where such raceways pass through a partition the iron pipe required for passing through floors may be omitted and the raceway passed directly through, providing the partition is dry and the raceway is in a continuous length with no joint or coupling within the partition.

d. The heads of screws or bolts placed within the raceway must be flush with the metal.

e. Must have the metal of raceways grounded as required in No. 15A.

f. Must be installed so that for alternating systems the two or more wires of a circuit will be in the same metal raceway.

It is suggested that this be done for direct current systems also, so that they may be changed to the alternating system at any time, induction troubles preventing such change if the wires are in separate raceways.

30. Fixtures.

(For construction of Fixture Wires see No. 52.

For construction of Fixtures see No. 77.

For Gas-Filled Lamps see No. 35.)

a. Must, except in the cases mentioned in items 1-4 inclusive below, be insulated from their supports by approved insulating joints placed as close as possible to the ceilings or walls.

Where insulating joints are required, fixture canopies of metal must be thoroughly and permanently insulated from metal walls or ceilings or from plaster walls or ceilings on metal lathing and from outlet boxes. Canopy

insulators must be securely fastened in place so as to separate the canopies thoroughly and permanently from the surface and outlet boxes from which they are designed to be insulated.

Gas pipes must be protected above the insulating joints or blind hickey by *approved* insulating tubing, and where outlet tubes are used they must be of sufficient length to extend below the insulating joint, and must be so secured that they will not be pushed back when the canopy is put in place.

Insulating joints and canopy insulators may be omitted in the following cases:

1. Straight electric fixtures connected to knob and tube, wooden raceways or open work, except on metal ceilings or on plaster walls or ceilings containing metal lathing.

2. Straight electric fixtures in which all wires have an *approved* rubber insulation not less than three sixty-fourths inch in thickness and which are metallically connected in a permanent and effective manner to metal conduit, armored cable or metal raceway systems or to gas piping, provided such gas piping is grounded in the manner prescribed for conduit in No. 15A.

3. Straight electric fixtures in which all wires have an *approved* rubber insulation not less than three sixty-fourths inch in thickness and which are permanently and effectively grounded to a separate ground wire not smaller than No. 14 B. & S. gage.

4. Combination fixtures in which all wires have an *approved* rubber insulation not less than three sixty-fourths inch in thickness and where gas piping is grounded, as in Item 2 above.

For fixtures which are not attached to gas pipes or conduit unless outlet boxes or other *approved* fittings which will give proper support for fixtures are used, a seven-eighths inch block must be fastened between studs or floor timbers flush with the back of lathing to hold tubing and to support fixtures. When this cannot be done, wooden base blocks, not less than  $\frac{3}{4}$  inch in thickness, securely screwed to lathing, must be provided.

Fixtures having so-called flat canopies, tops or backs, will not be *approved* for installation, except where outlet boxes are used.

b. When installed out of doors, must be of water-tight construction.

c. Fixture wires must be not smaller than No. 18 B. & S. gage, and must have an *approved* rubber insulating covering (see No. 52).

In wiring certain designs of show-case fixtures, ceiling bulls-eyes and similar appliances in which the wiring is exposed to temperatures in excess of 120 degrees Fahrenheit (49 degrees Centigrade), from the heat of the lamps, conductors having *approved* slow-burning or other heat resisting coverings must be used. All such forms of fixtures must be submitted for examination, test and approval before being introduced for use.

d. Supply conductors, and especially the splices to fixture wires, must be kept clear of the grounded part of gas pipes, and, where shells or outlet boxes are used, they must be

made sufficiently large to allow the fulfillment of this requirement.

e. Must, when wired on the outside, have the conductors so secured as not to be cut or abraded by the pressure of the fastenings or motion of the fixture.

Must not, when wired on the outside, be used in show windows or in the immediate vicinity of especially inflammable stuff, except as provided in No. 32 e for chain fixtures.

Chain fixtures must be wired with flexible conductors.

f. Wires of different systems must never be contained in or attached to the same fixture, and under no circumstances must there be a difference of potential of more than 300 volts between wires contained in or attached to the same fixtures.

g. Must be free from short circuits between conductors and from contacts between conductors and metal parts of fixtures, and must be tested for such conditions before being connected to supply conductors.

### 31. Sockets.

(For construction of Sockets see No. 72.)

a. In rooms where inflammable gases may exist the incandescent lamp and socket must be enclosed in a vapor-tight globe, and supported on a pipe-hanger, wired with *approved* rubber-covered wire soldered directly to the circuit.

b. In damp or wet places, or where exposed to corrosive vapors, weatherproof sockets especially *approved* for the location must be used. Unless made up on fixtures they must be hung by separate *stranded* rubber-covered wires not smaller than No. 14 B. & S. gage, which should preferably be twisted together when the pendant is over three feet long.

These wires must be soldered direct to the circuit wires but supported independently of them.

c. Sockets and receptacles installed over specially inflammable stuff or where exposed to flyings of combustible material, must be of the keyless type, and, unless individual switches are provided, must be installed at least seven and one-half feet above the floor, or must be so located or guarded that the lamps cannot be readily backed out by hand.

d. When the socket is not attached to a fixture, the inlet must be provided with an *approved* insulating bushing, which, if threaded must be not less than  $\frac{3}{8}$ -inch pipe size.

The edges of bushings must be rounded and all inside fins removed so that in no case will cord be subjected to the cutting or wearing action of a sharp edge.

Bushings should have holes not less than  $\frac{3}{2}$ -inch in diameter for plain pendant cord, and  $\frac{1}{2}$ -inch in diameter for reinforced cord.

### 32. Flexible Cord.

(For construction of Flexible Cord see No. 51.)

a. Must have an *approved* insulation and covering.

b. Must not, except in street railway property, 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, portable lamps or motors, portable heating apparatus or other portable devices.

For all portable work, including those pendants which are liable to be moved about sufficiently to come in contact with surrounding objects, flexible wires and cables especially designed to withstand this severe service must be used.

When necessary to prevent portable lamps from coming in contact with inflammable materials, or to protect them from breakage, they must be surrounded with a substantial guard, which should be securely attached to the socket or handle.

e. Unless provided with *approved* metal armor, must not be used in show windows or in show cases, except that *approved* portable cord may be used for the purpose of supplying current to portable lamps and other devices for exhibition purposes, and flexible cord may be used for chain fixtures.

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

g. Must be so connected to all fittings that strain is taken from the joints and binding screws.

h. Must where passing through covers of outlet boxes be protected by *approved* bushings especially designed for this purpose, or the cover must be provided with a smooth, well-rounded surface on which the cord will bear. So-called hard rubber or composition bushings must not be used.

### 33. Arc Lamps on Constant-potential Circuits.

a. Must have a cut-out (see No. 19 a) for each lamp or each series of lamps.

The branch conductors must have a carrying capacity about fifty per cent in excess of the normal current required by the lamp.

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

c. Must be supplied with globes and protected by spark arresters and wire netting around the globe, as in the case of series arc lamps (see No. 21).

Outside arc lamps must be suspended at least eight feet above sidewalks. Inside arc lamps must be placed out of reach or suitably protected.

d. Lamps when arranged to be raised and lowered, either for carboning or other purposes, shall be connected up with stranded conductors from the last point of support to the lamp, when such conductor is larger than No. 14 B. & S. gage.

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

### 34. Vapor Lamps.

#### Enclosed Mercury Vapor Lamps.

a. Must have cut-out for each lamp or series of lamps except when contained in single frame and lighted by a single operation, in which case not more than five lamps should be dependent upon single cut-out.

b. Must only be furnished with such resistances or regulators as are enclosed in non-combustible cases, such resistances to be treated as sources of heat. In locations where these resistances or regulators are subject to flyings of lint or combustible material, all openings through cases must be protected by fine wire gauze.

#### High-potential Vacuum Tube Systems.

c. The tube must be so installed as to be free from mechanical injury or liability to contact with inflammable material.

d. High-potential coils and regulating apparatus must be installed in *approved* steel cabinet not less than one-tenth inch in thickness; same to be well ventilated in such a manner as to prevent the escape of any flame or sparks, in case of burnout in the various coils. All apparatus in this box must be mounted on slate base and the enclosing case positively grounded. Supplying conductors leading into this high-potential case to be installed in accordance with the standard requirements governing low-potential systems, where such wires do not carry a potential of over 300 volts.

### 35. Gas Filled Incandescent Lamps.

a. Must be so grouped that not more than 660 watts (nor more than 16 sockets or receptacles) are to be dependent on one cut-out, except that in cases where wiring equal in size to No. 14 B. & S. gage is carried directly into keyless sockets or receptacles, the location of which is such as to render unlikely the attachment of flexible cords thereto, the circuits may be so arranged that not more than 1,320 watts (or 32 sockets or receptacles) will be dependent on the final cut-out. Where a single socket or receptacle is used on a circuit the limitation of watts permissible on the final cut-out shall be the maximum capacity for which such socket or receptacle is *approved*.

b. Must not be used in show windows or in other locations where inflammable material is liable to come in contact with lamp equipment except where used in connection with *approved* fixtures where temperature of any exposed portion of same does not exceed 200 degrees Fahr. (93 degrees Centigrade).

c. Must not be used in connection with medium-base sockets or receptacles if of above 200 watts nominal capacity nor with Mogul base sockets or receptacles if of above 1,500 watts capacity. If of above 100 watts, must not, if provided with a shade, reflector, fixture or other enclosure above the socket, be used in either medium or Mogul base types of sockets or receptacles having fibre or paper linings.

d. Fixtures within buildings must be wired with conductors having *approved* slow-burn-

ing or other heat-resisting coverings where the temperature to which wire is subjected at any point exceeds 120 degrees Fahr. (49 degrees Centigrade). Where fixtures are placed outside of buildings approved rubber insulated wire is required.

### 36. Transformers.

(See also Nos. 11, 14, 15 and 45.) For construction of Transformers see No. 81.

#### Oil Transformers.

a. Must not be placed inside of any building except central stations and sub-stations, unless by special permission.

#### Air Cooled Transformers.

The following sections do not apply to apparatus or fittings, the operation of which depends either wholly or in part upon special transformers embodied in the devices, but all such apparatus or fittings must be submitted for special examination and approval before being used.

b. Must not be placed inside of any building excepting central stations or sub-stations, if the highest voltage of either primary or secondary exceeds 550 volts.

c. Must, with the exception of bell ringing and other signaling transformers, be so mounted that the case shall be at a distance of at least one foot from combustible material or separated therefrom by non-combustible, non-absorptive insulating material, such as slate, marble or soapstone. This will require the use of a slab or panel somewhat larger than the transformer.

### 37. Decorative Lighting Systems.

Special permission may be given in writing for the temporary installation of approved Systems of Decorative Lighting, provided the difference of potential between the wires of any circuit shall not be over 150 volts and also provided that no group of lamps requiring more than 1,320 watts shall be dependent on one cut-out.

The following rules apply to those electrical circuits and parts of electrically operated organs which are employed for the control of the sounding apparatus and keyboards.

They do not apply to motors, switches, resistance devices or other appliances connected to light or power circuits which must in all cases be installed in compliance with the rules of this Code applying to low potential circuits.

### 37A. Electrically Operated Organs.

#### a. Source of Energy.

The source of energy must be either a self-excited generator rated at not over fifteen volts or a primary battery.

The generator must either be permanently and effectively insulated both from ground and from the motor driving it or both generator and motor must have their base frames permanently and effectively grounded.

#### b. Cables.

All wiring must be cabled except common return wires and wires inside the organ proper, the organ sections and the organ console.

The separate conductors of the cable must not be smaller than No. 26 B. & S. gage and have either rubber, cotton or silk insulation. The cotton or silk may be saturated with paraffine if desired.

The separate conductors may be either bunched or cabled and must be covered by one or more braided outer coverings. A tape may be substituted for an inner braid. The outside covering of cables not run in conduit must either be flameproof or covered with a closely wound fireproof tape.

The common return wire or wires shall not be contained in the cable, but may be run in contact with it or placed under an additional covering enclosing both cable and return wires.

The insulation of return wires must be either rubber or slow burning and not smaller than No. 14 B. & S. gage.

#### c. Workmanship and Materials.

All wiring and devices within the organ or any of its parts must be neatly disposed and securely fastened.

It is not found to be either necessary or feasible in organ structures to require the use of non-combustible, non-absorptive insulating material for the supports or enclosures of current-carrying parts.

Cables between parts of the organ and between the console and the organ must be installed in a workmanlike manner, be securely fastened in position and kept from contact with other wires. Conduit may be used but is not required.

#### d. Fuses.

Circuits must be so subdivided and protected at the generator by approved enclosed fuses of not over thirty amperes capacity that every wire will be protected by one or more such fuses.

No other fuses in the organ circuits will be required.

### 38. Theatre and Moving Picture Establishment Wiring.

All wiring, apparatus, etc., not specifically covered by special rules herein given, must conform to the general requirements of this Code, and the term "theatre" shall mean a building, or that part of a building regularly or frequently used for dramatic, operatic, moving picture or other performances or shows or which has a stage for such performances used with scenery or other stage appliances.

#### a. Services.

Where supply may be obtained from two separate street mains, two separate and distinct services must be installed, one service to be of sufficient capacity to supply current for the entire equipment of theatre, while the other service must be at least of sufficient capacity to supply current for all emergency lights. Where supply cannot be obtained

from two separate sources, the feed for emergency lights must be taken from a point on the street side of main service fuses. By "emergency lights" are meant exit lights and all lights in lobbies, stairways, corridors, and other portions of theatre to which the public have access, which are normally kept lighted during the performance.

Where source of supply is an isolated plant within same building, an auxiliary service of at least sufficient capacity to supply all emergency lights must be installed from some outside source, or a suitable storage battery within the premises may be considered the equivalent of such service.

#### b. Stage.

All permanent construction on stage side of proscenium wall, except as hereinafter provided, must be *approved* conduit or armored cable.

#### c. Switchboards.

1. Must be made of non-combustible, non-absorptive insulating material, and where accessible from stage level must be protected by a suitable guard-rail to prevent accidental contact with live parts on the board and comply with the requirements of Rule 3. \*

2. Dimmers must be dead when the switch controlling circuit of which dimmer forms a part is open.

#### d. Footlights.

Must be wired in *approved* conduit or armored cable, each lamp receptacle being enclosed within an *approved* outlet box, or the lamp receptacles may be mounted in an iron or steel box, metal to be of a thickness not less than No. 20 U. S. Sheet Metal gage treated to prevent oxidation, so constructed as to enclose all the wires and providing at least one-half inch separation between the metal of the box and receptacle terminals. Wires to be soldered to lugs of receptacles.

Must be so wired that no set of lamps requiring more than 1,320 watts nor more than 32 receptacles shall be dependent upon one cut-out.

#### e. Borders and Proscenium Sidelights.

1. Must be constructed of steel of a thickness not less than No. 20 U. S. Sheet Metal gage, treated to prevent oxidation, be suitably stayed and supported, and so designed that flanges of reflectors will protect lamps.

2. Must be so wired that no set of lamps requiring more than 1,320 watts nor more than 32 receptacles shall be dependent upon one cut-out.

3. Must be wired in *approved* conduit or armored cable, each lamp receptacle to be enclosed within an *approved* outlet box, or the lamp receptacles may be mounted in an iron or steel box, metal to be of a thickness not less than No. 20 U. S. Sheet Metal gage treated to prevent oxidation, so constructed as to enclose all wires. Wires to be soldered to lugs of receptacles.

4. Must be provided with suitable guards to prevent scenery or other combustible material coming in contact with lamps.

5. Cables for borders must be of *approved* type and suitably supported; conduit construction must be used from switchboard to point where cables must be flexible to permit of the raising and lowering of border.

6. For the wiring of the border proper, wire with *approved* slow-burning insulation must be used.

7. Borders must be suitably suspended, and if a wire rope is used same must be insulated by at least one strain insulator inserted at the border.

#### f. Stage and Gallery Pockets.

Must be of *approved* type, insulated from ground and controlled from switchboard, each receptacle to be of not less than 35 ampere rating for arc lamps nor 15 amperes for incandescent lamps, and each receptacle to be wired to its full capacity. Arc pockets to be wired with wire not smaller than No. 6 B. & S. gage and incandescent pockets with not less than No. 12 B. & S. gage.

Plugs for arcs and incandescent pockets must not be interchangeable.

#### g. Scene Docks.

Where lamps are installed in Scene Docks, they must be so located and installed that they will not be liable to mechanical injury.

#### h. Curtain Motors.

Must be of enclosed type and installed so as to conform to the general requirements of this Code. (See No. 8.)

#### i. Control for Stage Flues.

In cases where dampers are released by an electric device, the electric circuit operating same must be normally closed.

Magnet operating damper must be wound to take full voltage of circuit by which it is supplied, using no resistance device, and must not heat more than normal for apparatus of similar construction. It must be located in loft above scenery, and be installed in a suitable iron box with a tight, self-closing door.

Such dampers must be controlled by at least two standard single pole switches mounted within *approved* iron boxes provided with self-closing doors without lock or latch, and located, one at the electrician's station and others as designated.

#### j. Dressing Rooms.

Must be wired in *approved* conduit or armored cable. All pendant lights must be equipped with *approved* reinforced cord, armored cable, or steel armored flexible cord.

All lamps must be provided with *approved* guards which are sealed or locked in place.

#### k. Portable Equipment.

Arc lamps used for stage effects must conform to the following requirements:

1. Must be constructed entirely of metal of a thickness not less than No. 20 U. S.

Sheet Metal gage except where use of *approved* insulating material is necessary.

2. Must be substantially constructed, and so designed as to provide for proper ventilation, and to prevent sparks being emitted from lamps when same are in operation, and mica must be used for frame insulation.

3. Front opening must be provided with a self-closing hinged door frame, in which wire gauze or glass must be inserted, except in the case of lens lamps, where the front may be stationary, and a solid door be provided on back or side.

4. Must be so constructed that neither carbons nor live parts will be brought into contact with metal of hood during operation, and arc lamp frames and standards must be so installed and protected as to prevent the liability of their being grounded.

5. Switch on standard must be so constructed that accidental contact with any live portion of same will be impossible.

6. All stranded connections in lamp and at switch and rheostat must be provided with *approved* lugs.

7. Rheostats must be plainly marked with their rated capacity in volts and amperes, and, if mounted on standard, must be raised to a height of at least three inches above floor. Resistance must be enclosed in a substantial and properly ventilated metal case which affords a clearance of at least one inch between case and resistance element.

8. A competent operator must be in charge of each arc lamp, except that one operator may have charge of two lamps when they are not more than ten feet apart, and are so located that he can properly watch and care for both lamps.

#### **l. Bunches.**

Must be substantially constructed of metal and must not contain any exposed wiring.

The cable feeding same must be tubed in an approved manner where passing through the metal, and must be properly secured to prevent any mechanical strain from coming on the connections.

#### **m. Strips.**

Must be constructed of steel of a thickness not less than No. 20 U. S. Sheet Metal gage, treated to prevent oxidation, and suitably stayed and supported and so designed that flanges will protect lamps.

Cable must be tubed in a suitable manner where passing through the metal, and must be properly secured to prevent serious mechanical strain from coming on the connections.

Must be wired in *approved* conduit or armored cable, each lamp receptacle being enclosed within an *approved* outlet box, or the lamp receptacles may be mounted in an iron or steel box, metal to be of a thickness not less than No. 20 U. S. Sheet Metal gage, treated to prevent oxidation, so constructed as to enclose all wires. Wires to be soldered to lugs of receptacles.

#### **n. Portable Plugging Boxes.**

Must be constructed so that no current-carrying part will be exposed, and each receptacle must be protected by *approved* fuses mounted on slate or marble bases and enclosed in a fireproof cabinet equipped with self-closing doors. Each receptacle must be constructed to carry thirty amperes without undue heating, and the bus-bars must have a carrying capacity equivalent to the current required for the total number of receptacles, and *approved* lugs must be provided for the connection of the master cable.

#### **o. Pin Plug Connectors.**

Must be of an *approved* type, so installed that the "female" part of plug will be on live end of cable, and must be so constructed that tension on the cable will not cause serious mechanical strain on the connections.

#### **p. Portable Conductors.**

Flexible conductors used from receptacles to arc lamps, bunches and other portable equipments must be *approved* stage cable except that for the purpose of feeding a stand lamp under conditions where conductors are not liable to severe mechanical injury, an *approved* reinforced cord may be used, provided cut-out designed to protect same is not fused over ten amperes capacity.

#### **q. Lights on Scenery.**

Where brackets are used they must be wired entirely on the inside, fixture stem must come through to the back of the scenery and end of stem be properly bushed and fixtures to be securely fastened in position.

#### **r. String or Festooned Lights.**

Wiring of same must be of *approved* type, joints to be properly made, soldered and taped, and staggered where practicable.

Where lamps are used in lanterns or similar devices, *approved* guards must be employed.

#### **s. Special Electrical Effects.**

Where devices are used for producing special effects such as lightning, waterfalls, etc., the apparatus must be so constructed and located that flames, sparks, etc., resulting from the operation cannot come in contact with combustible material.

#### **t. Auditorium.**

All wiring must be installed in *approved* conduit, metal raceways or armored cable. Where receptacles are used they must be enclosed in *approved* boxes.

Exit lights must not have more than one set of fuses between same and service fuses.

Exit lights and all lights in halls, corridors or any other part of the building used by audience, except the general auditorium lighting, must be fed independently of the stage lighting, and must be controlled only from the lobby or other convenient place in front of the house.

All fuses must be enclosed in *approved* cabinets.

### 38A. Moving Picture Factories and Studios, and Moving Picture Equipments.

For the purposes of this rule a moving picture factory or studio is considered as that building or portion of a building in which moving picture films are manufactured, exposed, developed, printed, rewound, repaired, stored, etc.

a. All wiring must be installed in approved conduit, metal raceway or armored cable.

b. Side wall lamps must be installed in receptacles enclosed in approved outlet boxes, and must be protected by approved open end guards riveted to the covers of the boxes. Pendant lamps must be equipped with approved reinforced cord, armored cable or armored flexible cord, and must be protected by substantial wire guards.

Lamp portables must be equipped with approved keyless sockets, of approved composition or metal sheath porcelain type, with handle, hook and substantial guard. The flexible cords for such portable lamps must be approved cord designed for rough usage. The portable cord must carry the male end of an approved pin plug connector or equivalent, the female end being of such design or so hung that the connector will break apart readily at any position of the cable. The connector must be kept at least one foot above the floor.

Lamps at patching tables must be installed in approved composition or metal sheath porcelain keyless sockets, and must be suitably protected from mechanical injury.

c. In vaults used for storage of films, lamps must be protected by vaporproof globes, rigidly installed, and must be controlled by a double pole switch located outside each vault. No lamp portables or electric fans will be permitted in said vaults.

d. Motors must be of the enclosed type. Motor rheostats must be installed in metal cabinets of such design that all live terminals or contacts are enclosed leaving only the operating handles exposed.

#### e. Moving Picture Equipments Other Than Those of Approved Miniature Type.

1. *Arc Lamps*.—Arc lamps must be constructed entirely of metal of a thickness not less than No. 24 U. S. Sheet Metal gage, except where use of approved insulating material is necessary, and be constructed in so far as practicable in accordance with the requirements of No. 38 k, 2, 3, 4 and 6, and incandescent lamps must be suitably enclosed.

2. *Rheostats*.—Rheostats, transforming devices or any substitute therefor, must be of types expressly designed and approved for the purpose. Their installation and location must be subject to approval as parts of the moving picture machine.

3. *Top and Bottom Reels*.—Must be enclosed in steel boxes or magazines, each with an opening of approved construction at bottom or top, so arranged as not to permit entrance of flame to magazine. No solder is to be used in the construction of these magazines. The front side of each magazine

must consist of a door swinging horizontally, and be provided with a substantial latch.

4. *Automatic Shutter*.—Must be provided and must be so constructed as to shield the film from the beam of light whenever the film is not running at operating speed. Shutter must be permanently attached to the gate frame.

5. *Extra Films*.—Must be kept in individual metal boxes equipped with tight-fitting covers.

6. *Machine Operation*.—Must be of an approved type. If driven by a motor, must be of a type expressly designed and approved for such operation, and when so approved, motor driven machines, when in charge of a skilled operator, may be authorized under special permission in writing given in advance.

7. *Machine Enclosure*.—Machine must be placed in an enclosure or house made of suitable fireproof material; must be properly lighted and large enough for operator to walk freely on either side of or back of machine.

Ventilation for permanent booths must be provided by means of a vent pipe having a cross section of not less than 78 square inches; said pipe leading to the outside of the building or to a special non-combustible vent flue. All parts of vent pipe to be at least one inch from any combustible material or separated therefrom by means of approved non-combustible heat insulating material not less than one-half inch in thickness. A fan capable of exhausting fifty cubic feet of air per minute shall be installed and arranged in such a way that gas and smoke passing through the vent flue shall not come in contact with the motor. The motor must be connected to the emergency service and must not be controlled from the booth.

All openings into this booth must be arranged so as to be entirely closed by doors or shutters constructed of the same or equally good fire-resisting material as the booth itself. Doors or covers must be arranged so as to be held normally closed by spring hinges or equivalent devices.

8. *Reels Containing Films Under Examination or in Process of Rewinding*.—Must be enclosed in magazines or approved metal boxes similar to those required for films in operation, and not more than two feet of film shall be exposed in booth.

#### f. Moving Picture Equipments of Approved Miniature Type for Home, Lecture and Similar Purposes.

1. All equipments must be expressly approved, and such approval must cover the entire machine including all attachments, current-controlling devices and other parts employed, including also the film.

2. The entire equipment must consume not more than 660 watts.

3. Arc lamps must be constructed so far as practicable in accordance with the requirements of No. 38 k, 1, 2, 3, 4 and 6, and incandescent lamps must be suitably enclosed.

4. Rheostats, transformers, switches and other similar current-controlling devices

must be attached to and form a part of the machine, must have no live parts exposed, and must comply with the requirements of No. 65 and No. 78 or No. 81 a, b, c.

5. Films must be of an *approved* slow-burning type having a permanent distinctive marker.

6. Machines must be so constructed that they cannot be used with films employed on the full-sized commercial moving picture machine. This may be accomplished by using a film of special width or with special perforations or by any other approved means.

The regular film which is not allowed on miniature machines is  $1\frac{3}{4}$  inches wide and has on each edge 5.4 perforations per inch.

7. Machines must be marked with the name or trade-mark of the maker, and with the voltage and current rating for which they are designed, and be plainly marked, "For use with slow-burning films only."

### 39. Outline Lighting.

(Other than Signs on Exterior of Buildings.)

a. Must be connected only to low-potential systems.

b. Open or conduit work or metal trough construction may be used but moulding will not be permitted.

c. Where flexible tubing is required, the ends must be sealed and painted with moisture repellant and kept at least one-half inch from surface wired over.

d. Wires for use in rigid or flexible steel conduit must comply with requirements for conduit work. Where armored cable is used, the conductors must be protected from moisture by lead sheath between armor and insulation.

e. Must be protected by its own cut-out, and controlled by its own switch; single pole switches must not be used. Cut-outs, switches, flashers and similar appliances must be of *approved* types and be installed as required by the Code for such appliances, and, if outside the building, must, with the exception of transformer of weatherproof type, be installed in *approved* weatherproof cabinets.

f. Circuits must be so arranged that not more than 1,320 watts will be dependent upon one cut-out.

g. Sockets and receptacles must be of the keyless porcelain type and wires must be soldered to lugs on same. Miniature receptacles will not be approved for outdoor work.

h. For open work, wires must be *approved* rubber covered, not less than No. 14 B. & S. gage and must be rigidly supported on non-combustible, non-absorptive insulators, which separate the wires at least one inch from the surface wired over. 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 those parts of circuits where wires are connected to *approved* receptacles which hold

them at least one inch from surface wired over, and which are placed not over one foot apart, such receptacles will be considered to afford the necessary support and spacing of the wires. Between receptacles more than one foot, but not more than two feet apart, an additional non-combustible, non-absorptive insulator maintaining a separation and spacing equivalent to the receptacles must be used. Except as above specified, wires must be kept apart at least two and one-half inches for voltages up to 300, and four inches for higher voltages.

i. For metal trough construction, the troughs and other details must comply with the requirements of No. 83 a to f, inclusive.

### 40. Car Wiring and Equipment of Cars.

*The following rules apply to all cars or locomotives used for electric railway service, and cars or locomotives for other railway service which are equipped with electric circuits, and operating on either low or high potential systems.*

#### a. Protection of Car Body, Etc.

1. Where the underside of car bodies is composed wholly or in part of combustible material under which any apparatus is mounted, a protection of *approved* fire resisting and heat insulating material not less than  $\frac{1}{4}$  inch in thickness, or sheet iron or steel not less than .04 inch in thickness must be provided as follows:

2. Over motor trucks the protection must extend the entire width of the car and lengthwise of the car to a distance of at least 12 inches beyond the area under which the flexible motor leads, contact shoe leads, brake shoes and motor exclusive of gear case, may come in any operating position. In all cases fireproof material or sheet iron or sheet steel must have joints well fitted and must be securely fastened, and the whole surface must be treated with a moisture repellant paint.

3. Over resistances, contactors, lightning arresters, air compressor motors and other electrical apparatus and conductors, except where their casings provide approved protection for the car body, non-metallic, fire resisting, heat insulating material must extend to the edge of the car or not less than 8 inches beyond all edges of the devices.

4. All conductors (except flexible motor leads, leads over grid resistance and as provided in Sec. d, paragraph 7), on the underside of car bodies, must be installed either in *approved* conduit or in *approved* totally enclosed fire resisting ducts. Leads must be brought out of conduits or ducts through *approved* fittings.

#### b. Wires, Cables, Etc.

1. All conductors must be stranded and must comply with the requirements of this Code for rubber-covered wires and cable.

Fixture wire will not be permitted.

The allowable carrying capacity of wires shall be determined by Table A of No. 18, except that motor, trolley and resistance leads shall not be less than No. 7 B. & S.

gage. For heater circuits, arc headlight and air compressor circuits, conductors shall be not less than 6,000 circular mils cross section area, and for lighting and other auxiliary circuits conductors shall be not less than 4,000 circular mils cross section area.

The leads between the car body and main motors shall be flexible and triple braided.

The current values used in determining the size of motor, trolley and resistance leads shall be the per cent of the full load current, based on one hour rating of the motor, as given by the following table:

| Size each motor | Motor leads | Trolley leads | Resistance leads |
|-----------------|-------------|---------------|------------------|
| 75 H.P. or less | 50%         | 40%           | 15%              |
| Over 75 H.P.    | 45%         | 35%           | 15%              |

2. Must be so spliced or joined as to be both mechanically and electrically secure without solder. The joints must then be soldered and covered with an insulation equal to that on the conductors. Joints made with approved splicing devices and those connecting the leads at motors, plows or third-rail shoes need not be soldered.

3. Cable connections to all apparatus, excepting drum controllers, must be made as follows:

Cables not larger than No. 12 B. & S. gage must be attached, (a) by having all strands dipped in solder and clamped under a screw head, and against a metal base provided with a projection or lug for retaining the cable under the screw head, or (b) by a flat terminal soldered to the cable and clamped to a base or post by means of a screw or nut, or (c) by inserting all strands in a hole in a block or post and holding by a set screw, or (d) by other approved method of connection.

Cables larger than No. 12 B. & S. gage must be attached, (a) by a terminal soldered to the cable and securely fastened to the device by a bolt or screw or by clamping, or (b) the end of cable may be held by a clamp so designed as to prevent a separation of the cable strands, or (c) the end of the cable after the insulation is removed shall be dipped in solder and be fastened into the device by means of at least two set screws having check nuts, or (d) by other approved method of connection.

#### c. Cut-outs, Circuit-Breakers and Switches.

1. Cut-outs must be of approved cartridge or approved blowout type. Circuit-breakers and switches including oil circuit-breakers and oil switches must be of approved types.

2. All cut-outs and switches having exposed live metal parts must be located in cabinets. Cut-outs and switches not in iron boxes or in cabinets, must be mounted on not less than one-fourth inch fire-resisting insulating material, which must project at least one-half inch beyond all sides of the cut-out or switch.

3. Cut-out and switch cabinets must be substantially made of steel not less than one-sixteenth inch in thickness or of hard wood. For cabinets containing switches or cut-outs having exposed live metal parts, the entire inside including the door must be lined with

an approved fire-resisting insulating material not less than one-quarter inch thick, securely fastened and treated with a moisture repellent paint.

4. Circuits carrying constant loads, such as lighting, heater circuits, etc., must not be fused at more than the rated capacity of the cables as given in Table A of No. 18.

5. Light, control, heater and auxiliary circuits may be taken off ahead of the main power cut-out but must each be separately fused.

6. Circuit-breakers may be housed in a cabinet of metal or of wood lined with approved fire-resisting insulating material not less than one-quarter inch thick. Care must be taken that the arc chute is placed so that the arc will not come in contact with any woodwork or grounded metal. With lined wooden cabinets the conduit carrying the wires must end just outside the cabinet.

7. Where power is derived from both a third rail and an overhead trolley, a switch must be installed by which the third-rail shoe may be cut out when not in use.

#### d. Conduit.

When from the nature of the case, or on account of the size of the conductors, the ordinary conduit and junction box construction is not possible, a special form of conduit system may be used, provided the general requirements as here given are complied with.

When conduit is used, outlets must be provided with approved outlet boxes, or when wires are fully protected from mechanical injury, the outlet box may be omitted and conduit fitted with an approved bell mouth or approved bushing.

1. Conduits, outlet and junction boxes must be of approved type.

Conduit for lighting, heating and air compressor circuits need not be larger than one-quarter inch electrical trade size. Where exposed to dampness, conduit system must be so installed as to exclude moisture from wheel wash and other causes.

2. Conduit must be continuous between and be firmly secured into all outlet or junction boxes and fittings, making a thorough mechanical and electrical connection between same.

3. Conduits, where they enter all outlet or junction boxes and fittings, must be provided with approved bushings fitted so as to protect cables from abrasion.

4. Conduit must be permanently and effectively grounded.

5. Junction and outlet boxes must be installed in such a manner as to be accessible.

6. All conduits, outlets or junction boxes and fittings must be firmly and substantially fastened to the framework of the car.

7. For A. C. circuits carrying over 150 amperes and located wholly below the car body, conduit may be omitted.

#### e. Raceways.

Must be of an approved type, and may be installed only where not subject to moisture. Metal raceways must be permanently and effectively grounded.

#### f. Lighting and Lighting Circuits.

1. Receptacles and clusters must be of approved type.

2. Circuits must be run in *approved* conduit or *approved* metal raceways, except that for circuits of 700 volts or less conductors may be installed in approved non-metallic raceways.

3. When conduit or metal raceways are used, receptacles or clusters must be mounted on *approved* outlet boxes or in other approved manner, and the exposed metal parts must be thoroughly grounded.

4. When circuits are run in non-metallic raceways, receptacles or clusters must be mounted on blocks of hardwood or fire resisting insulating material.

5. Headlight circuits when under the car body must be in conduit. Resistance must be well ventilated and mounted as specified in section a. Plugs and plugging receptacles must be of *approved* type.

6. Lamp or voltage regulators and controllers for axle-driven or power-driven generator equipments for car lighting service must be installed in *approved* cabinets and ventilated.

7. Storage batteries for car lighting or car control must be installed in an approved manner.

#### g. Heaters and Heater Circuits.

1. Heaters must be of *approved* type. Metal enclosures must be thoroughly grounded.

2. Panel heaters should preferably be mounted in metal risers set back at least 4 inches from front edge of seat to prevent pocketing of heated air by clothing of passengers.

The heating element must be located at least 4 inches from all unprotected woodwork. If the woodwork is protected by at least one-quarter inch thick approved fire-resisting insulating material, this distance may be reduced to 2 inches.

3. Heaters for cross seats must be so located that heating element will be at least 6 inches below combustible material of seats, unless underside of seat is protected by not less than one-fourth inch fire-resisting insulating material, or .04 inch sheet metal with 1 inch air space over same, when the distance may be reduced to 3 inches.

4. Circuits must be run in *approved* conduit and connection of wires to heater must be protected from mechanical injury.

#### h. Auxiliary Motor Circuits.

1. Motor frame must be thoroughly grounded. Motors when in a confined space must be in an approved metal box or a wooden box lined with one-quarter inch fire-resisting insulating material and ventilated.

2. Circuits under car floor must be run in metal conduit.

3. Air compressor governor must be of the enclosed type or must be enclosed in an *approved* cabinet or box.

#### i. Main Circuits and Devices.

1. Conductors connecting between trolley base and main cut-out or circuit-breakers must have an insulation approved for the voltage carried, and where run lengthwise of the car must be run on a wooden strip mounted on three-eighths inch filler blocks, located at such a distance apart as to allow water to pass freely under it. The running board may be used for this purpose. The trolley lead must be securely fastened to trolley base, must be arranged to prevent the entrance of moisture where passing through roof.

2. Current collectors (such as trolley stands, pantographs, third-rail shoes, etc.) must be supported on well-seasoned and thoroughly painted hardwood or other insulating supports approved for the voltage carried.

3. Conductors connecting between third-rail shoes on same truck must be supported in a hardwood or insulating raceway, or in metal conduit. If the conductor is run in conduit, it must be fused as near as possible to the contact shoe before entering the conduit.

4. Conductors on the underside of the car must be run in metal conduit. Junction boxes, or other *approved* fittings, must be installed where branches in conduit are made. Main cables between controllers (at either end of the car) may be in cable boxes in the interior of the car. Cable boxes, if of wood, must be at least five-eighths inch thick, lined with one-quarter inch fire-resisting insulating material, with *approved* floor bushings.

Cables or power circuits (where exposed under car floor) must be run in metal conduit, terminating with *approved* bell mouths or bushings. Conduits, where they terminate above the car floor, must project at least 1 inch above the floor line of the car body or platform.

5. Motor leads where leaving the motor shell must be snugly and well bushed with high grade rubber bushings. Motor leads must be rigidly supported on the motor frame by hardwood or other *approved* cleats. Motor leads must be connected with cables on car body by *approved* connecting devices. Motor leads must be fastened to car body by hardwood cleats placed on each side of the motor lead connectors; or motor leads may be connected to cables on car body in an *approved* form of junction box.

6. Resistances must be so located that there will be at least six inches air space between resistance proper and the fire-resisting, insulating protection of the combustible material of the car. Resistance grids must be thoroughly insulated from resistance frames, and frames must be insulated from supports.

The insulation must be removed from conductors for at least six inches back from resistance terminal. The bare stranded wire must be filled with solder to make it rigid.

7. The frames of all electrical apparatus under the car, except the main and auxiliary motors and transformers, may be insulated from the car framing.