

ARTICLE 24.RESISTANCE DEVICES.2401 - Construction.

- a. Rheostats, resistance boxes and equalizers intended for use in dusty or liny places, or where exposed to flyings of combustible material shall be so constructed as to confine and quickly extinguish any arc or flame caused by the burning out of the resistive conductor, and shall be equipped with dustproof face plates. For locations other than those above specified, these devices may be of any approved type. (See Sections 2303 and 2304.)
- b. Resistance devices shall be made entirely of non-combustible materials, except such minor parts as handles, magnet insulation, etc. All segments, lever arms, etc., shall be mounted on non-combustible, non-absorptive insulating material.
- c. Reactive coils shall be composed of non-combustible material, mounted on non-combustible bases and treated generally as sources of heat.
- d. Condensers shall be provided with non-combustible cases and supports, and shall be installed in the manner provided for other apparatus operating with equivalent voltages and currents.
- e. Resistance devices shall be so constructed that when mounted on a plane surface, the casing will make contact with such surface only at the points of support, an air space of at least $\frac{1}{4}$ -inch being maintained between the casing and the surface.
- f. The terminals of motor-starting rheostats shall be marked to indicate the part of the circuit to which each terminal is to be connected, as "line," "armature" and "field."
- g. Fixed and movable contacts shall be so designed and so connected to the resistive conductor that there will be a minimum of arcing and consequent roughening of the contacts, even with careless handling or in the presence of dirt. In motor starting rheostats, the point or plate on which the arm rests when in the starting position shall have no electrical connection with the resistive conductor.
- h. Where insulated conductors are used for connections between resistance elements and the contact devices of a rheostat, the insulation shall comply with the requirements of Section 901(e).
- i. Resistance devices shall be plainly marked, where the marking may be readily seen after the device is installed, with the rating and the name of the maker.

2402 - Installation.

A. Resistance devices shall be placed on a switchboard, or at a distance of at least 1 foot from combustible material, or shall be separated therefrom by a slab or panel of non-combustible, non-absorptive material, such as slate, soapstone or marble. This slab shall be somewhat larger in area than the resistance device and shall be secured in position by its own supports which shall be independent of those fastening the resistance device to the slab. Bolts which support the resistance device shall be countersunk at least $1/8$ inch below the rear surface of the slab and shall be covered with insulating material. The slab shall have a thickness proportioned to the size and weight of the resistance device, in order to provide proper mechanical strength, and this thickness shall be not less than $1/2$ inch.

b. Live parts of resistance devices shall be protected against accidental contact as required by section 2304(b) of this code. If enclosures are used, they shall be thoroughly ventilated.

2403 - Lamp Resistances.

a. Where protective resistances are necessary in connection with automatic rheostats, incandescent lamps may be used, provided they do not carry or control the main current nor constitute the regulating resistance of the device.

b. When used as resistance, lamps shall be mounted in porcelain receptacles attached to non-combustible supports and shall be so arranged that they cannot have impressed upon them a voltage greater than that for which they are rated. They shall in all cases be provided with a name-plate, which shall be permanently attached beside the porcelain receptacle or receptacles and stamped with the wattage and voltage of the lamp or lamps to be used in each receptacle.

c. Incandescent lamps may be used for the purpose of resistance in series with other devices, by special permission when mounted in porcelain receptacles upon non-combustible supports and when so arranged that they cannot have impressed upon them a voltage greater than that for which they are rated.

ARTICLE 25SWITCHBOARDS

NOTE:- The requirements for panel boards and other distributing centers are given in sections 1307 to 1309 inclusive.

2501 - General Requirements.

- a. Switchboards with switches of the exposed knife blade type shall not be used unless installed in central stations sub-stations, motor rooms, switchboard rooms or in other locations which are accessible only to authorized qualified persons. Theatre stage switchboards shall comply with section 3613(a) of this Code.
- b. Live parts of switchboards (whether on the front or back) shall be protected from accidental contact and mechanical injury. This protection shall be provided by enclosing and guarding or by isolating them on a platform, gallery, or balcony.
- c. Adequate illumination shall be provided for both the front and back of all switchboards.
- d. Switchboards shall be so placed as to reduce to a minimum the danger of communicating fire to adjacent combustible material and shall be so located that they will not be exposed to moisture.
- e. Switchboards shall not be built up to the ceiling, a space of three feet being left, if possible, between the ceiling and the board. The space back of the board shall be kept clear of rubbish and shall not be used for storage.

2502 - Material and Wiring.

- a. The bases of switchboards shall be made of non-combustible material.
- b. All connections, wiring, and devices installed on switchboards shall be arranged in an orderly and workmanlike manner.
- c. Busbars, if rigidly mounted, may be of bare metal and shall have a cross-sectional area of not less than one square inch for each 1000 amperes.

- d. Insulated conductors, where closely grouped, as in the rear of switchboards, shall each have a substantial, flame-proof outer covering. Flame proofing shall be stripped back on all conductors a sufficient distance from the terminals to give the necessary insulation for the voltage of the circuit on which the conductor is used.
- e. Exposed bare parts of different potential on any switchboard shall be as few as practicable, and these parts shall be effectively separated.
- f. In wiring switchboards, the ground detector, volt-meter, pilot lights and potential transformers shall be connected to a circuit that is protected by 15 ampere fuses.
- g. The metal frame work of switchboards and the cases or other exposed bare metal parts of instruments, meters, relays, etc., shall be grounded as prescribed in section 1704 of this Code. The secondary circuits of current and potential transformers shall be isolated or grounded as required by section 1702(a) of this Code.

2503 - Switches, Outlets and Meters on Switchboards.

- a. All switches, fuses, and circuit breakers shall be plainly marked to afford ready means for identifying the circuits or equipment supplied through them.
- b. All circuit fuses installed on switchboards of the open knife switch construction shall be located on the front of the board. Fuses used for the protection of instrument circuits only (such as volt-meter circuits, relay circuits, coil circuits of automatic and auto manual control devices, etc.) may be installed on the back of the board, but shall be so located that persons renewing them will not be liable to come into contact with adjacent live parts. On dead-front switchboards, fuses may be located on the back of the board, provided they are enclosed in individual compartments or are so located that persons are not liable to come into contact with bus bars or other live parts when renewing the fuses.
- c. Meters shall not be mounted on the back of switchboards. They may be installed on a sub-panel in rear of switchboard provided they are so located as to permit ready and safe access to all parts requiring attention, inspection, adjustment or repair.

2504 - Working Space About Switchboards and Control Panels.

- a. All working spaces shall have a minimum head room of 6 feet. Unguarded live parts over such working spaces shall be maintained at not less than the following elevations:

Volts	Minimum Elevation of Unguarded Live Parts
0-150	7 feet
151-600	7½ "
601-2500	8 "
Over 2500	8½ "

b. When the connections are on the back, switchboards and control boards shall have working spaces provided and maintained as follows:

1. Where the switchboard or control board consists of a single panel not more than 24 inches wide, the minimum clear working space back of the board shall be 18 inches and, at one side of the board, 24 inches. No working space shall be required at the opposite side.

2. Where the switchboard or control board consists of one or more panels and has a total width of not more than 48 inches, the minimum clear working space back of the board shall be 18 inches and, on each side of the board, 24 inches.

3. Where the switchboard or control board consists of one or more panels and has a total width of more than 48 inches, there shall be provided and maintained at one side of the board a clear space of not less than 24 inches; where practicable, this clearance shall be provided at each side of the board. Where there are parts requiring attention, inspection, adjustment or repair on the backs of such switchboards or control boards and where there are live parts exposed on one side of the working space behind such boards and no live or grounded parts are exposed on the opposite side the minimum clear working space shall be not less than as follows: 0 to 600 volts, 2½ feet; 601 to 2500 volts, 4 feet; over 2500 volts, 5 feet. Where there are live parts exposed on one side of the working space and live or grounded parts exposed on the opposite side; the minimum clear working space shall be not less than as follows: 0-600 volts, 3 feet; 601 to 2500 volts, 5 feet; over 2500 volts, 6 feet.

6. Where there are live parts normally exposed on the front of switchboards or control panels, the working space in front of such panels or boards shall be not less than 3 feet.

(Fine print note) It is the intent of the above rules to provide adequate clear working space with secure footing about all switchboards and control boards so arranged as to give authorized attendants ready and safe access to all parts requiring attention, inspection, adjustment, or repair. Working space will not be required back of assemblies of safety type switches or dead-front switchboards or motor control panels, when there are no renewable or adjustable parts (such as fuses, switches, etc.,) on the back and when all connections between busses and incoming or outgoing conductors are accessible from other locations than the back of the board or panel.

ARTICLE 26STORAGE OF PRIMARY BATTERIES AND RECTIFIERS.2601 - General.

a. Wiring and appliances supplied by storage or primary batteries shall comply with the requirements of this Code which apply to wiring and appliances fed from generators developing the same difference of potential.

2602 - Special Requirements - Installations over 50 K.W. hour Capacity.

a. The requirements of this section shall apply to non-portable storage batteries exceeding 50 kilowatt-hour capacity at the 8-hour rate of discharge. Non-portable storage batteries of lesser capacity shall, if deemed necessary, be also installed in compliance with these requirements.

b. Storage batteries shall be made inaccessible to other than properly qualified persons, by being placed in a separate room or enclosure.

c. The battery room shall be so ventilated as to remove acid spray and prevent dangerous accumulation of inflammable gas.

d. The cells, unless of a type especially designed to prevent leakage of the electrolyte to the surface upon which they are placed, shall be separated from such surface by suitable insulators, such as glass or thoroughly vitrified glazed porcelain.

e. Metal susceptible to corrosion shall not be used in the cell connections of storage batteries.

f. Conductors in battery rooms shall be run exposed in accordance with the requirements of paragraph (b), Section 907, of this Code.

2603 - Charging Equipment for Portable Batteries.

a. Rectifiers (either mercury arc or vibrating type) shall be installed to conform to all requirements of this Code which are applicable to the installation of other equipment of like capacity and voltage.

b. All conductors except the bus bars used with constant potential charging systems and except those which must necessarily

be flexible shall be installed in rigid metal conduit. Flexible conductors shall be of a suitable type designed for the particular use to which they will be subjected. Charging cables in garages shall comply with section 3605 of this Code.

c. Open knife switches shall not be used unless the equipment is located in a room or enclosure which is accessible only to qualified authorized persons. Such switches shall be grouped on a panel or switchboard.

d. Resistance devices shall be installed as prescribed by Article 24 of this Code. They shall be installed at one location or at as few different locations as practicable.

ARTICLE 27TRANSFORMERS2701 - Air-Cooled Transformers.

NOTE: Nothing in this article shall be construed to apply to apparatus or fittings, the operation of which depends either wholly or in part upon special air-cooled transformers embodied in the devices; but all such apparatus or fittings shall be submitted for special examination and approval before being installed.

a. Transformers of the air-cooled type, when installed in central or sub-stations, shall be isolated from all other equipment and, if of the air-blast type, shall be supplied with air through fireproof ducts. Air-cooled transformers shall not be placed inside of other buildings if the highest voltage of either primary or secondary exceeds 600 volts.

b. The construction of an air-cooled transformer shall be such that when mounted on a plane surface the casing will make contact with such surface only at points of support, providing elsewhere an air space of at least $\frac{1}{4}$ inch between casing and surface. If the surface is composed of combustible material, the air space shall be increased to at least 1 foot, unless a slab of non-combustible, non-absorptive insulating material is interposed.

(Fine print note) This will require a slab of slate, marble or soapstone, somewhat larger than the transformer. (For exception see Section 1517(c)).

c. Transformers of 50 watts capacity and less used for bell-ringing, temperature control and similar purposes shall be installed as required by paragraph (b) of this section, unless mounted on an outlet or junction box cover or inclosed in a cabinet or cutout box. When inclosed in cabinets or cutout boxes, the secondary wires from such transformers shall be separated from other wires by barriers of code gage metal. Such transformers shall not be installed in closets, attics, or in any inaccessible place.

2702 - Oil-Filled Transformers.

a. No oil-filled transformer shall be placed within, nor attached to any building other than a central station or a sub-station, except by special permission. Plans shall be submitted to and approved by the Electrical Division prior to the commencement of the work.

b. If not installed on poles or pole structures, oil-filled transformers shall be installed to conform to one of the following methods:

1. In a transformer vault of approved design.
(See section 2703).

2. In an outdoor enclosure consisting of a fence not less than 8 feet high. If any current-carrying part extends to a greater height than 8 feet above the ground, the height of the fence shall be increased to 10 feet, unless it is located not less than 5 feet horizontally from the nearest current-carrying part. The fence shall be substantially constructed and so arranged that persons cannot readily climb over it. The gate shall be kept locked, and a permanent and conspicuous sign shall be posted forbidding unauthorized persons to enter.

5. Transformers of 75 K.V.A. or less used in connection with electric furnaces may be installed in the room or enclosure with the furnace, provided that such room or enclosure is of fire resisting construction, and that the transformers are surrounded by concrete curbs not less than 6 inches high, forming a basin of sufficient capacity to retain all of the oil used in all of the transformers.

4. If there is no combustible material in the vicinity, transformers of not over 600 volts and not over $7\frac{1}{2}$ K.V.A. capacity may be installed without any special requirements for enclosure. Such transformers shall be installed, controlled and protected as required by other sections of this Code for equipment operating at corresponding voltages and similar conditions. (See also Section 2203(c)).

c. Transformers installed on poles or pole structures shall be placed not less than 12 feet above the ground and at a distance of not less than 6 feet from any building.

(Fine print note) Where practicable, transformers on poles or pole structures or in outdoor enclosures should be kept at least 25 feet distant from any building. It is strongly recommended that transformer sub-stations be constructed of fire resistive material when located within 60 feet of other buildings.

2703 - Transformer Vaults.

a. The transformer vault or enclosure shall consist of concrete not less than six inches in thickness, or of brick not less than eight inches in thickness, except that when the total

transformer capacity so enclosed is not over 100 kilovolt amperes, the above thickness may be reduced to four inches, provided the construction of the vault is specifically approved by the Electrical Division. Outside walls of the building, if of fireproof construction shall, if practicable, constitute one or more of the walls of the vault or enclosure.

b. A suitable drain shall be provided which will carry off any accumulation of oil or water that may collect in the vault. Floor and drain shall have a pitch of not less than one-fourth inch per foot. In vaults containing transformers having a total capacity of 100 kilo-volt amperes or less, the drain may be omitted if the enclosure is so constructed as to retain all of the oil used within the vault.

c. Unless access is from the outside of buildings only, the doorway to the vault shall be thoroughly closed by means of a standard underwriters' fire door, hung with standard underwriters' hardware. A door sill not less than 4 inches in height shall be provided. In all cases the sill shall be of sufficient height to confine within the vault the oil from the largest transformer installed.

d. The enclosure shall be ventilated by means of an air inlet placed not more than one foot above the floor and an outlet at the ceiling line. The area of the inlet and outlet shall not be less than one square inch per K.V.A. of installed transformer capacity. No ventilating opening shall have an area less than 60 square inches.

e. The air outlet specified in paragraph (d) of this section shall be connected with a chimney, flue or other suitable vent leading to the outside of building. The air inlet shall be provided with standard two-ply underwriters' vertical sliding fire shutters unless opening to the outside air. Such fire shutters shall be controlled either manually or automatically, but if the control be manual, it shall be operable from a point outside the vault.

2704 - Accessibility and Working Space.

a. Adequate working space with secure footing shall be maintained about all electrical supply equipment in the transformer vault which requires adjustment or examination during operation. This space shall be so arranged as to give ready access to all parts requiring attention and shall provide the following minimum working spaces:

b. If there are exposed parts on one side only, not less than three feet; if there are exposed parts on both sides, not less

than five feet. When this space cannot be maintained, suitable enclosures, or barriers, shall be provided. There shall not be less than six inches air space on all sides of the transformer. There shall, if practicable, be clear head room of eight feet.

c. The enclosure shall be used only for enclosing the transformers and other apparatus pertaining thereto and shall be kept securely locked, access to same being allowed only to authorized persons. (See section 2902).

2905 - Transformer Connections - Grounding.

a. Each transformer or bank of transformers shall be suitably protected by overload circuit breakers or cutouts on the primary side, except that approved bell-ringing or signalling transformers of 50 watts capacity or less may be connected to branch circuits with other devices if the circuit is protected by fuses rated at not more than 15 amperes.

b. Transformers operating at more than 600 volts shall have all wiring and equipment installed as prescribed by Article 29 of this Code.

c. No auto transformer shall be used in any lighting installation unless the requirements of section 803(b) can be complied with.

d. When a small two-coil transformer is used to supply lighting circuits from power circuits, the switches and cutouts for control and protection of the lighting circuits may be placed either in the primary or secondary, and the secondary circuit need not be grounded unless the primary voltage exceeds 600 volts.

e. The casings of transformers and other apparatus connected with the high potential circuit shall be grounded as prescribed by Article 17 of this Code.

f. Transformers connected with low potential circuits, shall have their casings effectively grounded where practicable.

ARTICLE 23LIGHTNING ARRESTERS.2301 - In Stations or Substations.

- a. Where deemed necessary, lightning arresters shall be attached to each conductor of every overhead circuit connected with a station or sub-station.
- b. Lightning arresters shall be located in readily accessible places, away from combustible materials, and as near as practicable to the point where the conductors enter the building.
- c. In all cases, kinks, coils and sharp bends in the conductors between the arresters and the outdoor lines shall be avoided as far as possible.
- d. All choke coils or other attachments, inherent to the lightning protection equipment, shall have an insulation from the ground or other conductor equal at least to the insulation demanded at other points of the circuit.
- e. Lightning arresters shall be well isolated from all other equipment and, if of the oil-immersed type, shall be located outside or in a fireproof room or compartment in the premises, which shall be drained and provided with a high sill in the entrance door, so that no burning oil can flow into other rooms.
- f. Ground conductors shall be installed, as required by Article 17 of this Code.

(Fine print note) The special requirements relating to lightning arresters for Signal Systems and Radio Equipment are given in Articles 30 and 35 of this Code.

ARTICLE 29.SYSTEMS OVER 600 VOLTS.2901 - General.

NOTE:- For the requirements relating to transformer installations see Article 27.

a. The requirements of this Article shall be deemed additional to or amendatory of those prescribed in other articles of this Code.

b. Conductors of systems over 600 volts shall not be attached to any building except central stations or sub-stations. They shall not be run over the roof of any building except where other routes are not feasible. When carried over buildings they shall be supported on structures which are independent of the buildings and shall have a minimum vertical clearance of 12 feet above the highest point of the roof.

(Fine print note) The minimum height above roof as specified in this section need not necessarily be maintained where conductors enter an isolated building used as a sub-station; but where this height is not maintained, the conductors shall be suitably guarded.

c. Conductors or equipment of systems over 7500 volts shall not be installed in, attached to, or carried over buildings other than central stations or sub-stations; provided, however, that conductors of such systems may be brought into and equipment installed in transformer vaults within buildings.

d. Motors operating at a potential exceeding 2500 volts to ground shall not be installed elsewhere than in central stations, sub-stations, and generator and motor rooms.

e. Open wires of less than 7500 volts between conductors, when run adjacent to buildings, shall be at least 3 feet horizontally from such buildings unless 6 feet higher than the roof. Open wires of voltages between 7500 and 15,000 volts between conductors shall be kept at least 3 feet horizontally, and open wires of more than 15,000 volts between conductors shall be kept at least 10 feet horizontally from all buildings except central stations or sub-stations. (See also section 1603).

2902 - Location of Equipment.

- a. All vaults, rooms, and other similar enclosures containing any exposed live parts (including exposed wiring, whether bare or insulated), shall be kept securely locked or other suitable provision shall be made to limit access only to authorized qualified persons. A permanent and conspicuous sign, forbidding unauthorized persons to enter, shall be provided at each entrance. Transformer vaults shall comply with Section 2703 of this Code.
- b. Oil circuit breakers and oil switches which are used for the control of transformers operating at more than 600 volts shall, when they are located in a building, be installed in the enclosure with the transformers which they control, unless in a separate enclosure of equivalent construction. They shall be so arranged that they may be tripped without entering the transformer enclosure when and as required by Section 1504 of this Code.
- c. Switches, cutouts, or other equipment, operating at 600 volts or less, shall not be installed in the same room or enclosure where there are any exposed live parts or exposed wiring (either bare or insulated) operating at more than 600 volts; provided, that in central stations or sub-stations the low-potential equipment may be installed in the same enclosure if effectively separated from the space occupied by the high-potential equipment by a suitable partition, fence or screen.

2903 - Service Requirements.

- a. All services operating at more than 600 volts shall be run underground from the supply line to the building. Multiple conductor, metal sheathed cable shall be used which shall be installed in rigid metal conduit, plugged or drifted iron or steel pipe, fibre conduit, tile, concrete duct, or other similar conduits or ducts except that, within buildings, rigid metal conduit or other approved piping of equivalent strength and thickness shall be used.
- b. Services (other than noted in paragraph (c) of this Section), operating at more than 600 volts, shall be controlled and protected by an automatic overload oil circuit breaker. Such circuit breaker shall comply with all properly applicable requirements given in Section 1508 of this Code.
- c. If the service does not supply, at the primary voltage, any equipment except that contained in a fireproof transformer vault, or if it enters only a detached transformer house or enclosure, then one of the following alternatives may be employed in lieu of the automatic oil circuit breaker required by paragraph (b) of this Section:

1. A non-automatic oil switch, installed in the transformer vault or enclosure, may be used, provided the service is properly protected against overload by fusible cutouts installed on the service riser pole, or in the transformer enclosure.

2. An air break switch may be used, provided it is installed on a service riser pole which is in a quickly and readily accessible location near the building and provided such switch is capable of safely interrupting the full connected load and is equipped with means for manual operation from the ground or a point near the ground. The switch shall be so constructed and installed that it will, when opened, simultaneously disconnect all service conductors and the fuses from the supply line. Such switches shall not be installed within buildings.

3. When the voltage between conductors does not exceed 5000 volts and the installed transformer capacity does not exceed 50 K.V.A. per phase, the service may be protected by standard fusible cutouts installed in the transformer enclosure or on the service riser pole.

d. Low-potential secondary feeders from transformers which are supplied at more than 600 volts shall be provided with service switch and cutout with the exceptions noted in section 1504 of this Code.

e. When an oil switch or oil circuit breaker operating at more than 600 volts is used as a service switch, suitable disconnectors shall be installed for isolating such service switch from the source of supply. If the oil switch or circuit breaker is installed in a building, the disconnectors may be installed in the building if installed in compliance with section 1411 of this Code or they may be installed on the service riser pole or on a pole not more than one span from the service pole, provided no other service is supplied through such switch and provided the switch is so arranged that it may be operated from the ground or a point near the ground and so that it may be locked in the open position.

(Fine print note) For services of 2500 volts and less to ground, standard primary cutouts, installed on the service riser pole or in transformer enclosure, may serve as the disconnecting means required by the above rule.

2904 - Wiring Methods - Systems over 600 Volts.

a. Elsewhere than in central stations, sub-stations, and generator, transformer, switching, and motor rooms, all apparatus and wiring connected to circuits of more than 600 volts shall be completely enclosed by substantial metal shields or casings. Conduit shall properly enter and be so secured to such shield or casing, or to suitable terminal boxes secured or bolted to the casing, that an effective electrical and mechanical bond will be established. The entire system, including conduit and all boxes, casings, etc., shall be grounded as prescribed in Article 17 of this Code.

b. Elsewhere than in central stations, sub-stations, and generator, transformer, switching and motor rooms, all wiring of circuits of more than 600 volts shall consist of approved multiple-conductor, grounded metal-sheathed cable enclosed in approved grounded conduit. Where the cable is not exposed to moisture, the metal sheath may be omitted by special permission. Where moisture is absent, the metal sheath need not be continued over splices; but where the metal sheath is required over the rest of the cable the ends of the sheath shall be belled out and bonded around the splices by No. 6 copper wire and ground clamps.

c. Where the cable emerges from its metal sheath, the insulation of the several conductors shall be thoroughly protected from moisture and mechanical injury by a pothead or equivalent device; provided, that, on the inside of casings or terminal boxes of equipment to which the conduit is connected, neither potheads nor insulating compound will be required when the voltage does not exceed 5000 volts, but the lead sheath shall be belled out and the conductors shall be taped and painted with an insulating compound.

d. In central stations, sub-stations, transformer, and switching rooms open work may be employed if the conductors are rigidly supported on suitable glass or porcelain insulators which keep them at least one inch from the surface wired over and not less than 8 inches apart except at apparatus and devices. Rigid supporting requires supports about 4½ feet apart when wiring along flat surfaces under ordinary conditions.

2905 - Vacuum Tube Systems.

a. The transformers, tubes, and other apparatus and the conductors in the high-potential circuit shall be especially approved for such use. The high-potential transformers and other high-potential apparatus, including tube terminals and all high-potential conductors, shall be installed in approved steel cabinets not less than No. 12 U. S. sheet metal gage. They shall be well ventilated in such manner as to prevent the emission of any flame or sparks in case of burnout of any of the coils. The enclosing cases shall be permanently and effectively grounded.

b. The low-potential wiring leading into the high potential case shall comply with all applicable requirements of Article 10 of this Code.

c. The tubes shall be so installed as to be guarded from mechanical injury or liability to contact with inflammable material.

2906 - Static Condensers.

a. Static condensers of the type made up of small units, each of which contains less than three gallons of oil, may be installed in power houses or factory buildings if combustibles are kept well away from them. In rooms containing combustible dust or flying material, condensers shall be inclosed.

(Fine print note) If condensers are accessible to other than qualified persons a non-combustible grille or guard around them may be desirable.

b. Condensers which have all units in single tanks filled with oil shall be installed as required for oil filled transformers in Article 27.

c. For transformers used with static condensers, the requirements of Article 27 shall be followed; provided, however, that by special permission oil-filled transformers intended for and used only with static-condenser installations and not subject to lighting disturbances may be installed in rooms of non-combustible construction and occupancy. Such transformers shall be of sufficient capacity to allow for ordinary rises in voltage; they shall be surrounded by concrete curbs not less than 6 inches high which form a basin of sufficient capacity to retain all the oil contained in the transformers; and be protected by an automatic overload circuit-breaker (or other protective device and switch) set to operate at a current corresponding to not over 150% of the rated capacity of the condenser.

2907 - X-Ray and High Frequency Apparatus.

a. Low-potential supply conductors shall be installed as prescribed by Article 10 of this Code. An approved safety type switch shall be installed in the low-potential circuit to each machine within sight of the machine it controls.

b. In each circuit supplying a high-frequency machine or group of machines there shall be installed an approved device which will protect the wiring in the building from high-potential surges and induced currents. This protection may consist of one of the following devices connected between each wire and ground:

(1) A mica condenser of not less than $1/2$ microfarad capacity; (2) A resistance rod; (3) An incandescent lamp; (4) An aluminum lightning arrester (on direct current systems only). These devices shall be installed at, or near, the machine and must be connected at all times when the circuit to the high-frequency apparatus is energized.

c. Adequate mechanical barriers shall be provided to prevent the operator from approaching within dangerous distance of all high-potential parts attached to the case (such as spark gap, millimeter, and outgoing wiring). Parts not so protected shall be completely and adequately insulated. It is recommended that glass be used for the mechanical barriers, as it permits examination during the operation of the machine. High-potential parts enclosed in a wooden cabinet of an X-ray or other high-frequency machine, shall be insulated sufficiently to prevent a discharge through the wall of the cabinet to the body of a person outside. All operating parts, such as spark gap handles and regulating handles, shall be made of suitable insulating material and shall be operative from the outside of the barriers.

d. Overhead high-potential wiring systems shall be so installed as to withstand a downward strain of 50 pounds. No overhead high-potential wires shall be placed at a distance less than 6 feet from the floor of the room, and no terminals from cord reels, or other conductors, shall be permitted to hang lower than 7 feet 6 inches from the floor, except when actually connected and in use. The high-potential leads on tilting tables and fluoroscopes shall be adequately insulated or so surrounded by barriers that contact with them is impossible. Tube terminals and high-potential wires leading thereto shall be adequately insulated for a distance of 12 inches from the terminals. Shields for this purpose shall be designed to carry the high-potential leads away from the patient in a direction at right angles to the long axis of the tube. No arrangement will be permitted which will enable more than one piece of apparatus to be connected to the same high-potential source at the same time.

e. All low-frequency current-carrying parts shall be adequately insulated or protected mechanically so that they can not be touched during operation. This applies to all circuits except the high-frequency circuit proper, which delivers high-frequency current normally for therapeutic purposes.

f. Transformers which are a part of X-ray or other high-frequency apparatus, even though they contain oil, are to be considered and treated as a part of the device, and need not be installed as required for light or power transformers.

g. All tube stands and fluoroscopes shall have their frames, operating handles, and all non-current-carrying metal parts grounded. For grounding, a flexible stranded cable is preferable to a solid wire which may break or become disconnected.

ARTICLE 30SIGNALLING SYSTEMS

NOTE:- This Article does not apply to radio equipment, for which see Article 35 of this Code. Signal systems of the class noted in item 3 of section 804 (a) must be installed in compliance with all applicable requirements for light, heat and power installations.

3001 - Outside Wires.

- a. Outside wires shall be placed in underground ducts, strung on poles, or attached to the walls of buildings or other structures. They shall not be run across or attached to roofs except by permission of the Electrical Division.
- b. Underground wires shall not be placed in a duct, handhole or manhole containing electric light or power wires. Where a handhole or a manhole is divided into sections by means of partitions of brick, concrete or tile, each compartment shall be considered as a separate handhole or manhole.
- c. Overhead wires shall not be attached to a crossarm carrying electric light or power wires, nor shall they, when on the exterior walls of buildings, be brought closer than four inches to electric light or power wires unless one system is in conduit, or is permanently separated from the other system by a continuous and firmly-fixed non-conductor, additional to the insulation on the wires.
- d. The metal sheath of aerial cables which are liable to contact with electric light or power wires shall be interrupted close to the entrance to a building by an insulating joint or equivalent device.
- e. The distance between the two inside pins of any cross-arm of a pole carrying signal and electric light and power wires shall be not less than 24 inches.

(Fine print note) It is recommended that signal wires, being smaller and more liable to break and fall, be placed on the lower crossarms.
- f. Aerial cables of the metal-sheathed type may have paper or other suitable insulation. If the metal sheath is omitted, each wire shall have 1/32-inch rubber insulation and the wires shall be covered with a substantial braid and bunched.

g. Wires from the last outdoor support to the protector, (where protector is required) and wires attached to buildings shall conform to the requirements of paragraph (f) of this section. Where not in conduit, such wires shall be supported on glass or porcelain insulators or by insulated screw eyes.

h. Wires shall enter buildings either through non-combustible, non-absorptive, insulating bushings, or through approved rigid conduit except on telephone lines where fuses are placed on the outside of building and except where lines are not exposed as defined in Section 3003(c) of this code. Conduit or bushings shall slope upward from the outside, or, where this cannot be done, drip loops shall be formed in the wires immediately outside the point of entrance. The conduit shall be equipped with an approved service head. More than one wire may enter through one conduit or bushing.

3002 - In Buildings; Generally.

a. Wires beyond the protector, or wires inside buildings where no protector is employed, shall be neatly arranged and secured in place in a convenient, workmanlike manner. They shall not approach nearer than two inches to any electric light or power wire unless one system is in conduit or the two systems are permanently separated by a continuous and firmly-fixed non-conductor, additional to the insulation on the wires.

(Fine print note) The wires would ordinarily be insulated, but the kind of insulation is not specified, as reliance is placed on the protector to stop all dangerous currents. Porcelain tubes or approved flexible tubing are considered suitable non-conductors.

b. Wires bunched together in a vertical run shall have a fire-resisting covering sufficient to prevent the carrying of fire from floor to floor. This requirement shall not apply if the wires are encased in non-combustible tubing, or are located in a fireproof shaft having fire stops at each floor.

c. Signal wires and electric light and power wires may be run in the same shaft if the two systems are separated at least two inches, or if either system is encased in non-combustible tubing.

d. Signal wires shall not be placed in a tube containing electric light or power wires.

e. Transformers or other devices supplying current to signal systems from electric light or power circuits shall be of a type expressly approved for such service. The secondary wiring shall conform to the requirements of this article, and the primary wiring to the requirements of this code which are applicable to the installation or wiring of the current capacity and voltage employed. (See section 804.)

f. Whenever any device, appliance, or wiring has at any time, either continuously or momentarily, any direct electrical connection with any light, heat or power circuit, such device, appliance, or wiring shall be installed to conform to all applicable requirements of this Code for light, heat and power installations.

(Fine print note) The above rule will prevent the use of a resistance, rectifier, auto transformer, rotary converter, or similar device, in which there is direct electrical connection between incoming and outgoing leads for supplying energy from a light, heat, or power circuit to a signalling system unless the signalling system is installed in compliance with the rules for light, heat and power installation or unless a device especially approved for the purpose is provided for electrically insulating the signalling equipment from the light, heat, or power circuit.

3003 - In Buildings; Where the Distribution System Consists of Aerial Wires.

a. An approved protector shall be placed as near as practicable to the point of entrance to the building. The protector shall be mounted on a non-combustible, non-absorptive insulating base and shall consist of an arrester between each line wire and ground and a fuse in each line wire, the fuses protecting the arrester. The protector terminals shall be plainly marked to indicate "line", "instrument" and "ground."

b. The protector shall not be placed in the immediate vicinity of easily ignitable material or inflammable gases, or dust or filings of combustible material.

c. Where the entire street circuit is run underground, a protector shall not be required unless the circuit within the block is so placed as to be liable to accidental contact with electric light or power wires operating at a potential exceeding 250 volts.

3004 - Grounding.

a. The ground conductor of the protector shall consist of not less than No. 12 copper, having 1/32-inch rubber insulation, covered with a substantial braid. Where necessary, it shall be guarded from mechanical injury.

b. The ground conductor shall be run in as straight a line as possible to a permanent and effective ground. Where connection is made to a gas pipe, attachment shall be made between the meter and the street main. In every case the attachment shall be made as close to the earth as practicable.

(Fine print note) A suitable ground may be obtained by connection to either a water pipe or a gas pipe, preferably to the former. A ground rod or pipe driven into permanently damp earth is acceptable, in the absence of a piping system.

c. The ground conductor shall be attached to the pipe by means of an approved bolted clamp to which the conductor is soldered or otherwise connected in an approved manner, or the pipe shall be tinned with resin flux solder, after which the conductor shall be wrapped around the pipe and thoroughly soldered to it.

d. Steam or hot water pipes shall not be employed as a ground for protectors.

PART IV.**ARTICLE 31.****CRANES AND HOISTS.****3101 - General.**

a. All wiring, apparatus, etc., not specifically covered by special rules herein given, shall conform to all other applicable requirements of this Code.

3102 - Crane Conductors - Method of Installation.

a. All conductors, excepting bare collector wires shall be installed in rigid metal conduit, and no conductor smaller than No. 12 shall be used.

3103 - Crane Collector Wires - Method of Installation.

a. Collector wires shall be secured at the ends by means of approved strain insulators, and shall be so mounted on approved insulators that the extreme limit of displacement of the wire will not bring the latter within less than $1\frac{1}{2}$ inches from the surface wired over.

b. Main collector wires carried along runways shall be rigidly and securely attached to insulating supports placed at intervals not exceeding 20 feet. When run horizontally, such wires shall be separated not less than six inches; when run otherwise, not less than eight inches. Where necessary, intervals between insulating supports may be increased up to 40 feet, the separation between wires increased proportionately.

c. Bridge collector wires shall be kept at least $2\frac{1}{2}$ inches apart and, where the span exceeds 50 feet, insulating saddles shall be placed at intervals not exceeding 50 feet.

(Fine print note) It is recommended that the distance between wires be greater than $2\frac{1}{2}$ inches, where practicable.

d. Sizes of collector wire shall conform to the following table:

Distance between
rigid supports.

Size of wire.

0-20 feet

No. 3

21-50 feet

No. 4

Over 50 feet

No. 2

c. Rails or bars may be permitted in place of collector wires specified above, but the details of their construction and insulation shall be approved before installation.

3104 - Requirements for Collectors.

a. Collectors shall be so designed as to reduce to a minimum the sparking between them and the collector wire.

3105 - Requirements for Switches and Cutouts.

a. The main collector wires shall be protected by a cutout, and the circuit shall be controlled by a switch. The cutout and switch shall be so located as to be readily accessible from the floor.

b. Where cranes are operated from cabs, the cutout and switches specified in paragraph (a) of this section shall be inserted in the leads from the main collector wires, and shall be so located in the cab as to be readily accessible to the operator.

c. Where more than one motor is employed on a crane, each motor with its leads shall be separately protected by a cutout in accordance with the provisions of Section 1511 of this Code; provided, however, that where two motors operate a single hoist, carriage, truck or bridge and are controlled as a unit by one controller, the pair of motors with their leads may be protected by a single cutout. This cutout shall be located in the cab if there is one.

d. Alternating current motors which are dependent upon phase relation for direction of rotation, and which are liable to damage through phase failure, shall be protected from such hazard, as prescribed in Section 2505.

3106 - Requirements for Crane Controllers.

a. If the crane operates over readily combustible material, the resistance shall be placed in a well ventilated cabinet composed of non-combustible material, so constructed that it will not emit flame or molten metal.

(Fine print note) If the resistances are located in a cab, this requirement may be met by constructing the latter of non-combustible material enclosing the sides of the cab from the floor to a point at least 6 inches above tops of the resistances.

3107 - Grounding Crane Equipment.

a. Motor frames, tracks and the entire frame of the crane shall be grounded as prescribed in Article 17 of this Code.

ARTICLE 32ELEVATORS.3201 - General.

- a. All wiring, apparatus, etc., not specifically covered by special rules herein given, shall conform to the requirements of other articles of this Code insofar as they apply.

3202 - Installation of Wires and Cables.

- a. The flexible or traveling cables of the operating and lighting circuits shall be of approved Type E cord, and shall have a substantial flameproof outer covering. They may be run in properly bushed approved conduit where attached to the car, or may be run exposed and attached directly to the outer surface of the car extending thence to switches or fixtures within the car.
- b. Conductors for lighting cables shall be not smaller than No. 14, and for control cables, not smaller than No. 16.
- c. Conductors, other than lighting and control cables, where located in shafts, shall be enclosed in approved conduit or armor. Split tees and elbows may be used in conduit work, except where the pipe contains feeders.
- d. Signal conductors, other than those receiving energy from primary batteries or approved bell transformers, shall be enclosed in approved conduit equipped with approved terminal bushings, having an individual outlet hole for each conductor.
- e. The conductors of motor circuits between motors and control panel may be grouped together without any extra insulation of the separate wires, provided the complete group is either taped or corded and painted in a manner to make same a rigid, self-supporting form, not over three feet long and not in a position liable to mechanical damages or subject to a temperature in excess of 120 degrees F. (49 degrees C).
- f. All conductors between main circuit resistances and the back of control panels shall each have a flameproof outer covering as prescribed in Section 2502, paragraph (A) of this Code. All other wiring on control panels may be of the rubber-covered type, provided the wires are laid flat against the panel and held in such a manner as to be immovable and free from mechanical injury, and not subjected to a temperature exceeding 120 Degrees F. (49 degrees C).