Reference.	Circumstances.	Current.	Symptoms.	Result.	Post-mortem findings.	Treatment.
1. R. W. Pope: New York *Sun*, October 14th, 1895.	Accidental contact with wire in cellar of residence; heard to fall; found dead.	2,100 volts, alternating from converter; leakage possible.	Not given; found dead.....	Death	Deep ragged scratch on right hand and electrical burn; other minor burns.	
2. New York *Sun*, January 22d, 1896.	Faulty connections of wires. Current passed direct from dynamo to switch, omitting transformer; switch handle grasped.	2,000 volts, alternating.	Felt smarting pain in palm of right hand; no other pain for some minutes, then dizzy and fainted; soon recovered. Later spasms of pain in injured arm, running across breast to heart, which felt as if grasped in a vise. Red marks, shape and size of banana, under each ear; sensitive. On left arm, midway between shoulder and elbow, two irregular black and blue marks close together, one by one-half inch. Around these flesh inflamed and puffed up. Spasms of pain, forty at intervals of a few minutes; entire left side numb; blind forty-five minutes; delirious some hours; later, for several hours, unable to speak.	Recovery..	.....	Morphine, brandy, sinapisms to præcordium.
3. D'Arsonval: Comptes rendus de l'Acad. des Sciences, 1894, p. 1139.	Man sat astride of bar connecting wires, telephone wire in hand which touched another conductor.	4,500 volts, 750 ma., frequency 55 periods per second, duration several minutes.	Apparent death. Lungs began to act almost at once after artificial respiration began; burn on right hand and buttock.	Recovery..	.....	Artificial respiration. Method of Laborde. After two hours, spoke.
4. Cardew: London *Electrical Review*, March 15th, 1895.	Rubbing dust off high-pressure "terminal board"; neglect of rubber gloves.	2,000 volts, alternating.	Uttered loud cry; lost consciousness; remained standing leaning against the terminals.	Death	Not given	Artificial respiration.
5. Kratter: London *Lancet*, August 31st, 1895.	Workman stringing telegraph wires.	Not given	Not given	Death	Twenty-one hours after death. Ruptured blister on left forefinger. Marked rigor mortis; intense ecchymosis on dependent parts. Hypervenosity of blood; venous engorgement of lungs; blood extravasated into common sheath of carotid and vagus nerves on both sides. Symmetrical hemorrhages along spinal cord.	Not given.
6. Shield and Delphine: *Brit. Medical Jour.*, 1885, vol. i., p. 591.	Manipulation of electrical machine, accidental putting self in circuit.	Not given	Not given. No alteration perceptible in texture of clothes nor in metallic substances on the person.	Death	Forty hours after death. Rigor mortis marked; great cutaneous congestion; on left index finger small blister; appearance of burn, but no redness around it; no charred smell; muscles of thorax firm and resistant to knife; internal viscera healthy; extreme fluidity of blood; heart uncontracted; fibres under microscope normal; microscopic examination of sections of region of blister showed marked differences from common burn. (Described in detail.)	Not given.
7. Clowes: London *Lancet*, December 17th, 1892.	Making connections with house for street current.	2,000 volts, alternating, 10,000 per minute, 166+ per second.	Fell to one side as in a fit; five minutes after, heart and respiration were stopped; surface congested; pupils dilated; features not distorted; smell like gas; palm and first two fingers of left hand burned; fingers flexed; clothing not burned.	Death	Three days after death. Rigor mortis marked; decomposition not advanced; burns as described, deep and carbonized; epidermis of palmar surface burned black and separated; dorsal surface, epidermis destroyed in small circular spot; ecchymosis and swelling on right frontal eminence; vessels of scalp, meninges, brain, and brain substance congested and full of liquid blood; lateral sinuses full of blood; mucous membranes, larynx, trachea, and bronchi congested; lungs loaded with dark blood; heart not contracted, but cavities completely empty; deficiency of blood in large vessels; liver congested and dark red; spleen large and engorged with blood; kidneys large and congested; complete fluidity and dark color of blood; not a clot found in body.	Artificial respiration for one hour, no response; Strychnine hypodermically. Faradic current to præcordium.

8. New York *Herald*, May 31st, 1901.	Boy nine years old, caught hold of electric light wire passing over roof; insulation insufficient.	10,000 volts	Immediately swung off into air; smoke arising from the wire at point of contact. Boy's hold not loosened until hands were pounded; body dropped apparently lifeless.	Recovery..	.....	After boy supposed to be dead, artificial respiration practised; semi-consciousness produced, continuing twenty-four hours or more (not definitely stated).
9. Kolben: *Electrical World and Engineer*, March 17th, 1900, vol. xxxv., No. 11, p. 411. *Elek. Zeit.*, February 15th, 1900.	Workman in potash and alcohol plant stood on iron tank covered with soda lye of good conductivity; boots wrapped with rags of twilled linen; drunkard.	95 or 96 volts, alternating.	.....	Death.		
10. W. S. Hedley: London *Lancet*, December 5th, 1896.	Casually placed hand on metal corner of ammeter and, turning, placed other hand on iron pillar. Ammeter case in accidental metallic contact with light leads and return wire was earthed by contact with iron post.	2,500 volts, alternating.	Found himself standing on floor, forearm drawn up to chest, hands clenched; from above elbow downward described feeling of pulsation and violent beating in synchronism with alternations (83 periods per second); power of movement below elbow lost, but arm at shoulder could be moved; pulsation soon became less violent and motor power returned successively in the muscles of forearm, wrist, and fingers. In three minutes completely restored. No sensation of burning at the time, but in ten minutes hands became painful and examination revealed burn on tip of left middle and ring fingers, with scarred line across lower portion of palm. Since accident, claims to feel better in general health.	Recovery.		
11. London *Electrical Review*, February 23d, 1900.	Assistant in electric light station accidentally put hand on spring on switchboard. No insulation on floor.	3,000 volts, alternating.	Instantaneous death.....	Death	Cauterized wound on knuckle of left forefinger. Heart empty of blood; several small blood vessels shattered.	
12. London *Electrical Review*, June 15th, 1900.	Victim found dead with wire grasped in left hand, which was used to draw arc lamp up and down; leakage to wire.	700 volts, direct current.	Instantaneous death.....	Death.		
13. London *Electrical Review*, August 6th, 1897.	Employee at electric light station.	Not given	Instantaneous death.....	Death	Not stated.....	Artificial respiration one hour.
14. London *Electrical Review*, June 3d, 1898.	Employee at electric light station, switched off transformer without gloves.	2,000 volts, high-pressure, continuous current.	Instantaneous death.....	Death	Thumb of right hand with portion of joint burned off; tracing up arm where electricity ran; skin peeled off.	
15. London *Electrical Review*, September 2d, 1898. From *Cape Times*, August 8th, 1898.	Wireman working in transformer chamber caught hold of fuse handle; was removing some temporary electrical apparatus which had been used at a ball at Government House; rubber mat and rubber gloves within reach but not used.	1,500 volts	Spoke after shock but died immediately	Death	Left heart empty; blood did not coagulate. Rigor mortis strong after nineteen hours. Brain and other organs congested.	None.
16. London *Electrical Review*, October 21st, 1898.	Electric wireman fell across terminals of one of the machines in electric supply station; was crossing wires leading to a switch-board.	1,000 volts	Found dead in semi-reclining position.....	Death	Not given.	
17. London *Electrical Review*, July 24th, 1896.	Sub-foreman at electric light station; neglect of rubber gloves in making a connection.	Not stated	Instantaneous death.....	Death	Burn between thumb and index finger of left hand.	Artificial respiration. Time not given.
18. London *Electrical Review*, January 6th, 1899.	Workman making temporary joint on high-pressure cable.	2,000 volts	.....	Death	.....	Artificial respiration.

Reference.	Circumstances.	Current.	Symptoms.	Result.	Post-mortem findings.	Treatment.
19. London *Electrical Review*, January 27th, 1899.	Accidental contact with wires of arc-lamp circuit.	4,000 to 5,000 volts.	Fell immediately but rose, took three or four steps, and sank unconscious.	Death	....	Artificial respiration. Died on removal to place of shelter. Time not stated.
20. London *Electrical Review*, September 20th, 1898. *l'Industrie Electrique.*	A beam fell upon wires carrying them down upon workman, who was killed. The other workmen who went to his assistance were killed.	2,400 volts, alternating current.	Instantaneous death in the three cases	Death.		
21. *Revue Scientifique*, May 18th, 1901. (Variétiés.) ("Souvenirs d'un Electrocuté.")	Grasped two large electrodes; current passed two or three seconds before turned off.	Secondary current from a Ruhmkorff coil, excited by alternating current, 110 volts, 42 periods per second, about 20 ma., primary current 50 amperes.	No burn. Thrown to the ground by general muscular tetanus; could not cry out; lost sensation of upper limbs and trunk; perturbation of vertical and color sense; unconscious a few seconds; no pain. On trying to move arms and hands found them paralyzed. Hyperæsthesia to cold; loss of tactile sensibility and muscular sense; hyperæmia of hands and forearms. In three to four minutes arms recovered mobility; fifteen minutes hands the same; some hours after, interossei recovered. Same time, three to fifteen minutes, tactile sense and muscular sense recovered. Heat sense returned to normal half an hour later. At this time on trying to walk, out of breath. One hour and a half after, tachycardia, arrhythmia, continuing until next day; stopped suddenly. Lassitude lasted thirty-six hours.	Recovery.		

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ELECTROTHERAPEUTICS.—The knowledge of the therapeutic applications of electricity presupposes a thorough familiarity with the main principles of electrical effects upon tissues and organs, and also with the proper dosage of every form of electricity in every given case; it also presupposes a familiarity with the different forms of batteries used for therapeutic purposes. A series of observations shows that the blood-vessels contract and dilate when they are under the influence of an electrical current and that the normal irritability of nerves is changed when a current passes through them. This last phenomenon is called electrotonus. It has been observed that the anode of the galvanic current applied to a nerve diminishes its irritability, while the cathode increases it. The law of electrotonus is equally true of sensory and of motor nerves. Electrical stimulation of a motor nerve produces a contraction of the muscle innervated by the nerve and its branches. A current passing through a sensory nerve will produce pain, while a current influencing a mixed nerve will produce both effects—motor and sensory. Electricity causes muscles not only to contract but also to undergo changes of a trophic character.

Apart from the purely physiological influence upon blood-vessels, nerves, and muscles, electricity shows its chemical effects by means of cataphoresis and electrolysis. By cataphoresis we understand a phenomenon which partakes of the nature of osmosis and which is brought into existence by the action of a galvanic current upon organic tissues. Thus, for example, medicinal substances, as mercury, cocaine, chloroform, etc., can be transferred into the tissues when an electrical current passes through the skin to which the drugs are applied. By electrolysis we understand a splitting up of chemical compounds into their component elements, the acid element being set free at the positive, the alkaline element at the negative pole. In living tissues an acid, dry eschar is formed under the positive pole, an alkaline, moist slough under the negative pole.

Forms of Electricity for Therapeutic Purposes.—The forms of electricity used in therapeutics are: static, galvanic, and faradic.

The application of *Static Electricity* to the body for therapeutic purposes is known as Franklinization. This is the form of electricity which is developed by rubbing certain bodies, and which has the property of spreading over the electrical conductors (for example, metals) and of remaining there. The terminal portions of these bodies have more tension than the middle portions; at the sharp ends the tension is greatest. One distinguishes two sorts of this electricity—positive and negative. By contact with electrical bodies the non-electrical bodies become electrified. Also at a distance the electrical bodies have an influence over the non-electrical bodies (induction). If a non-electrical body is brought into close proximity with the negative pole, the body in question will be found to have assumed the character of a positive

pole. For therapeutic purposes one can use direct contact with either the positive or the negative pole. Several methods are employed in Franklinization: (*a*) *Insulation.* The patient is placed upon an insulator and is connected with one pole of the static machine by a chain. The free end of the other pole (also a chain) rests upon the floor. The machine is put in rapid motion. The patient is charged with static electricity. (*b*) *Sparks.* When a piece of metal attached to the free end of the chain is brought close to the patient's body, insulated as before, sparks will be obtained from it. Sparks are powerful means of exciting deep organs, as well as the skin, and the procedure is attended with pain. (*c*) *Breeze.* If instead of a ball electrode a pointed electrode is used, a sensation as of a spray will be experienced; this is called a breeze. (*d*) *Induced static current.* In this case a pair of sponge electrodes are attached to two Leyden jars, which are suspended from the poles of the machine. Before applying the sponge electrodes to the body, the poles should be approached to each other. An induced static current is thus obtained. One of the best electrodes for this purpose was devised by W. J. Morton, who named it a pistol electrode. Ranney's device (Fig. 1834) is a decided improvement for use in applying induced static electricity. Other electrodes used with static machines are: a plate for the head, in the form of a crown, and a button-shaped electrode.

Galvanic currents are used in therapeutics for general and for local applications. The different methods of employing galvanic currents are termed *central galvanization, local galvanization, general galvanization,* and that by means of the *galvanic bath.* In central galvanization one large negative electrode is placed over the epigastrium and the positive electrode over the head, along the spine, or against the trunk. Each *séance* should last not more than fifteen minutes. In local galvanization the rules of application are the same; the cathode should be placed on some indifferent spot, as the sternum or the neck, and the anode on the diseased spot. In general galvanization the patient is seated on a large negative electrode, well moistened, and the other electrode is applied first to the head, then to the neck, face, upper extremities, trunk, and lower extremities. As to galvanic baths we distinguish two varieties: *monopolar* and *bipolar.* In monopolar galvanic baths the cathode is connected with the water, while the anode is either connected with a tube lying over the bathtub, which the patient will hold in his hands, or with a large plate which is put on the patient's back or on some indifferent part of the body (sternum, neck). The bath is called cathodal, when the water is connected with the cathode, and vice versa. A bipolar galvanic bath consists of a bathtub, where both electrodes are connected with the water, and the patient is not in contact with either. The currents will pass through the body from one electrode to another. Each *séance* should last at the beginning about ten minutes. As to the strength of the current it may be permitted to reach 100 ma.

Faradic Electricity.—This form of electricity is used in therapeutics both in a general manner and as a local application. The utilization of general faradization is governed by the same rules as those given for general galvanization. The only point to be mentioned is that on account of our inability to measure exactly the strength of the current in a faradic battery we must guide ourselves by the sensory or motor effects. Local faradization which is used for stimulation of the skin, muscles, and deep structures, is obtained by using large sponge electrodes or dry brush electrodes. The method of application is exactly the same as that already mentioned. Special mention should be made of the combination of galvanic and faradic currents in one machine, but we do not as yet possess positive data as to the real value of farado-galvanization.

Therapeutic Effects of the Various Forms of Electricity.—*Static electricity* increases the blood pressure, accelerates the circulation, stimulates the function of secretory organs, and restores disturbed functions. Sparks and induced static electricity are indicated when a strong action is sought for. The advantage of Franklinization is that it can be applied through the clothing. *Faradic currents* have their effect upon muscular contractility and vaso-motor phenomena; this form of electricity is therefore indicated in effusions, which will be absorbed through the stimulation of the vascular system. In disorders of deep-seated organs faradism, by producing hyperæmia of the skin, will relieve congestion. *Galvanism* shows its effect in various ways. The vaso-motor effect will be manifested in the variation of the calibre of the blood-vessels. As to the trophic effect of galvanism, there is no doubt that atrophies are favorably influenced by this form of electricity. The chemical effects of galvanism are manifested in cataphoresis and electrolysis (see above). A special practical application

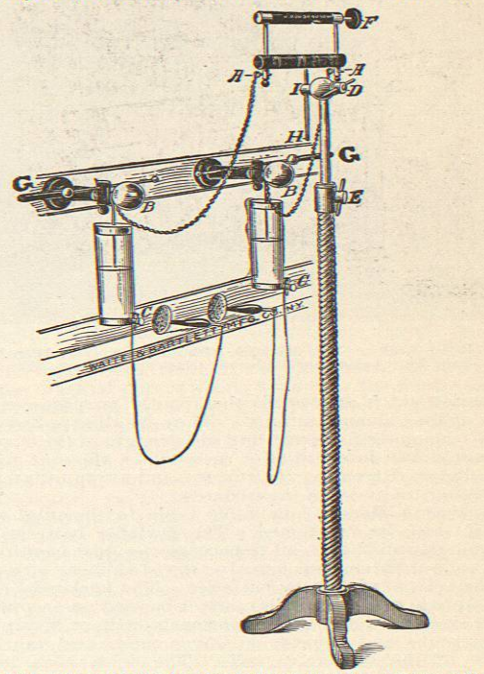

Fig. 1834.—Ranney's Device for Induced Current. To use this device, connect with short chains the poles of the static to binding posts *A A* on device. Use the current through well-moistened sponge-covered discs, the cord tips being connected to the binding posts attached to the Leyden jar supports. Press sponges firmly on part to be treated, and regulate strength by turning *F*.

of galvanic currents is furnished in galvano-cauterization. This surgical procedure has an important advantage over other methods of accomplishing the same results. First, hemorrhage is a rare occurrence, and next, the cauterized surface presents a clean aseptic appearance. In operations in the nose, throat, or other cavities, it has a decided advantage over the thermo-cautery in the fact that it is applied cold and heated while applied to the diseased spot. This form of electrical application is indicated in ulcers, in angiomata, in fistulæ, where a stimulation of healthy granulations is desirable, in growths which are to be removed from the nose, pharynx, etc.

Batteries Used in Electrotherapeutics.

The number of various batteries devised for electrotherapeutic purposes is considerable. They are made stationary and portable. The stationary *galvanic batteries* are the most satisfactory. The cells are put in a closet or cellar and connected with the switchboard by insulated wires. The cells present usually some modification