SOME EFFECTS OF LARGE CURRENTS.

BY GEO. M. HOPKINS.

During some of the earlier experiments with electricity as a motive power for railways, in which the rails were employed as conductors of the current, it was observed that the wheels which received the current from the rails had an enormously increased traction while the current passed. This was at first attributed to the direct action of the current, then to molecular change caused by the electrical heating of the surfaces in contact, but the phenomenon has never been fully explained.

The contact between the wheel and the rail under the conditions of actual use upon railways is scarcely more than a short line. If the surfaces were perfect as well as infinitely hard and rigid, the contact would be simply a mathematical line. In reality the surfaces in contact are very small, so that any current meeting the resistance of such a contact must produce some heat, which becomes greater as the current is increased. Experiments show that a current of several amperes, having a pressure of one volt or less, is required to secure good results.

Some interesting facts in regard to the local effects of large currents may be demonstrated by means of the simple apparatus shown in Fig. 1, in which a long pivoted index carries a jaw for holding a metal plate, *a*, the edge of which rests at right angles upon the edge of a metal plate, *b*, held by the fixed jaw. The free end of the index extends partly over the face of a scale secured to the base of the instrument. The two jaws are insulated from each other and connected by wires with a secondary battery or other source of electricity capable of supplying a six or eight ampere current with a pressure of from one to two volts. When this current passes through the metal plates held by the jaws, the parts in contact expand instantly, as shown by the upward movement of the index; and when the current ceases, the plates immediately contract, allowing the index to drop. Although the distance through which the index moves is small, it is measurable, and when the minuteness of the portion of the metal actually expanded is considered, it is seen that the expansion is very great. Different metals are not all affected in the same degree. As would be expected, the effect of the same current on good conductors, such as silver and copper, is less than it is on iron and German silver.

The molecular changes effected in the metals are analogous to those produced in the lead of the Trevelyan rocker. In this instrument, however, the expansion takes place in one only of the pieces of metal in contact, the other piece being contracted by the withdrawal of the heat by the cold metal.

The form of Trevelyan rocker shown in Figs. 2 and 4 has been designed with special reference to the comparison of the effects of heat from an external source, and heat generated within the metal by the passage of a current through a point of resistance. The clamps mounted upon the upright metal rods are arranged for holding plates of different metals. The rocking bar, which rests upon the edges of these plates, is of cylindrical form. In the side of the bar, at one end, is formed a narrow groove leaving ridges which rest upon the edge of one of the metal plates. In Fig. 2, the dark plate is lead. The rocking bar, of brass, is provided with a light index to show the vibrations. When this bar is heated by means of a flame, and placed upon the edges of the metal plates, with the ridges in contact with the lead plate, it rocks violently, and if the index be removed, the rocker gives forth a musical note, which continues until the heat of the bar is reduced below the operative limit. This action is due to the local expansion of the lead by contact with the ridges of the heated bar and the subsequent rapid cooling of the lead on the separation of the surfaces. These operations occur with great rapidity; the two ridges alternating in the production of the effects.

If, after cooling the heated parts, a heavy current is passed through the standards, the plates, and the bar, the same vibratory motion is at once set up, and while, in the case of the Trevelyan rocker, lead seems to be the only metal available for one of the surfaces, in the electrical rocker the results are the same in kind, although different in degree, with all the metals and alloys tried thus far.

To render the movements clearly visible, a pendulum is applied as shown in Fig. 4. The ring at the upper end of the pendulum rod is provided with a set screw, which allows it to be shifted from one rocking bar to another. This arrangement also permits of placing the pendulum and bar in working position, without the necessity of leveling the base of the instrument. The current from one small cell of secondary battery or from two large bichromate cells connected in parallel circuit is sufficient to cause the pendulum to begin to oscillate

from a state of rest, and to increase its amplitude of vibration until it describes an arc of about 30°. The heat generated by the current is conducted away so rapidly as to permit of continuous operation.

By raising the pendulum so as to bring the convex

Fig. 1.—APPARATUS FOR SHOWING LOCAL EXPANSION.

side of the rocking bar into contact with the edges of the plates, and drawing the bar along lengthwise of the plates, first without the current and afterward with

Fig. 2.—ROCKER FOR APPLIED HEAT.

the current flowing through the apparatus, a great increase in friction will be noticed as the current passes, the increased friction being due to the jutting out by

Fig. 3.—MODIFIED ROCKER.

expansion of points upon both the edges of the plates and the side of the rocking bar.

In Fig. 3 is shown a slightly modified form of rocker in which a plate with a graduated series of notches is used in connection with a cylindrical bar.

Fig. 4.—ELECTRICAL ROCKER.

In the case of the rocker with the attached pendulum the taps of the rocker upon the edge of the plate are as distinct and regular as the ticks of a French clock.

The Secret of Cheap Building.

A man who is resolved to be independent of landlords can build a very comfortable house for from \$2,000 to \$2,500. He can have sufficient room, and a house with a decent exterior and a plain interior. He ought, first and foremost, to provide a bath room, even if he cannot buy a slate mantel. It will be the wisest in the long run to have a bath room. Ask any woman who has had the care of two or three children how much a bath room saves them. The larger the family, the greater the saving in work and worry, which is more wearing than work. If a man has only \$2,000 and a large family, he must sacrifice something or deny himself something when he builds.

If he is wise, he will contrive closets and cupboards, a style of house that renders running up and down stairs unnecessary (there is nothing so tiresome as going up and down stairs), make his dining room large enough for a living room, and see that the arrangement of the kitchen is labor saving. Slate roof, slate mantels, bay windows and pretty trimmings can all be dispensed with. There are people who do not seem to have any clear idea of the things that are appropriate in a cheap house. We recall an instance where a gentleman, after looking at a design for a cheap house, expressed surprise at the cost, which was very low, and in the same breath he inquired if the house would be roofed with slate. A cheap house is not roofed with slate, it is needless to add. His next query had reference to the plumbing. If his ideas were realized, the plumber would charge at least \$300. Evidently, the gentleman thought the plumbing would cost about a third of that sum, or less.

To sum it all up, substantial fixtures rather than pretty trimmings. Good ventilation, ample room, plenty of light and warmth, may be obtained if a man desires to insure it in building for his own use, at a very moderate outlay. But then he must build to please himself instead of vying with his neighbor.—*Real Estate Record.*

Mineral Products of the United States.

Metallic Products of the United States in 1888.

Pig iron, spot value long tons, 6,489,738, \$107,000,000; Silver, coining value troy ounces, 45,783,632, \$59,195,000; gold, coining value, troy ounces, 1,604,927, \$33,175,000; copper, value at New York, pounds, 231,270,622, \$33,833,954; lead, value at New York, tons of 2,000 pounds, 180,555, \$15,924,951; zinc, at New York, tons of 2,000 pounds, 55,903, \$5,500,855; quicksilver, at San Francisco, flasks, 33,250, \$1,413,125; nickel, at Philadelphia, pounds, 195,182, \$115,518; aluminum, at Philadelphia, pounds, 19,000, \$65,000; antimony, at San Francisco, tons of 2,000 pounds, 100, \$20,000; platinum (crude), at New York, troy ounces, 500, \$2,000; total, \$256,245,403.

Non-Metallic Mineral Products of the United States.

Bituminous coal, tons of 2,240 pounds, 91,106,998, \$122,497,341; anthracite, tons of 2,240 pounds, 41,624,610, \$89,020,483; building stone, \$25,500,000; lime, barrels, 49,087,030, \$24,543,500; petroleum, barrels, 27,346,018, \$24,598,559; natural gas, \$22,662,128; cement, barrels, 6,253,095, \$4,533,639; salt, barrels, 8,055,881, \$4,377,204; limestone for iron flux, tons of 2,240 pounds, 5,438,000, \$2,719,000; phosphate rock, long tons, 433,705, \$1,951,673; zinc white, short tons, 20,000, \$1,600,000; mineral waters, gallons sold, 9,628,568, \$1,709,302; borax, pounds, 7,589,000, \$455,340; gypsum, short tons, 96,000, \$430,000; manganese ore, long tons, 25,500, \$255,000; mineral paints, long tons, 24,000, \$380,000; New Jersey marls, short tons, 600,000, \$300,000; pyrites, long tons, 54,331, \$167,658; flint, long tons, 30,000, \$175,000; mica, pounds, 48,000, \$70,000; corundum, short tons, 589, \$91,620; sulphur, short tons, —; precious stones, \$64,850; gold quartz, souvenirs, jewelry, \$75,000; crude barytes, long tons, 20,000, \$110,000; bromine, pounds, 307,386, \$95,290; feldspar, long tons, 8,700, \$50,000; chrome iron ore, long tons, 1,500, \$20,000; graphite, pounds, 400,000, \$33,000; flourspar, short tons, 6,000, \$30,000; slate ground, long tons, 2,500, \$25,000; cobalt oxide, pounds, 12,266, \$18,441; novaculite, pounds, 1,500,000, \$18,000; asphaltum, short tons, 53,800, \$331,500; asbestos, short tons, 100, \$3,000; rutile, pounds, 1,000, \$3,000; total, \$328,914,528.

Résumé.

Metals, \$256,245,403; mineral substances, \$328,914,518; mineral products unspecified, \$6,500,000; grand total, \$591,659,931.—*Eng. and Min. Jour.*

No consideration is sufficient in law if it be illegal in nature.