cracked or defective in use. The shellacked coils of a wheatstone bridge, potentiometer or other resistance apparatus may be dipped in melted paraffin and so be protected from moisture. A high grade of paraffin should be used; that is, paraffin of high melting point, free from dirt and acid. The paraffin coating, of course, slightly increases the lag of temperature of the coils when the temperature of the room is changing, but the increased error due to this would probably not be a hundredth part of the error that may be due to absorption of moisture.

Since a small and inexpensive coil sealed in a tube or covered by paraffin has a very constant resistance, one may possess a

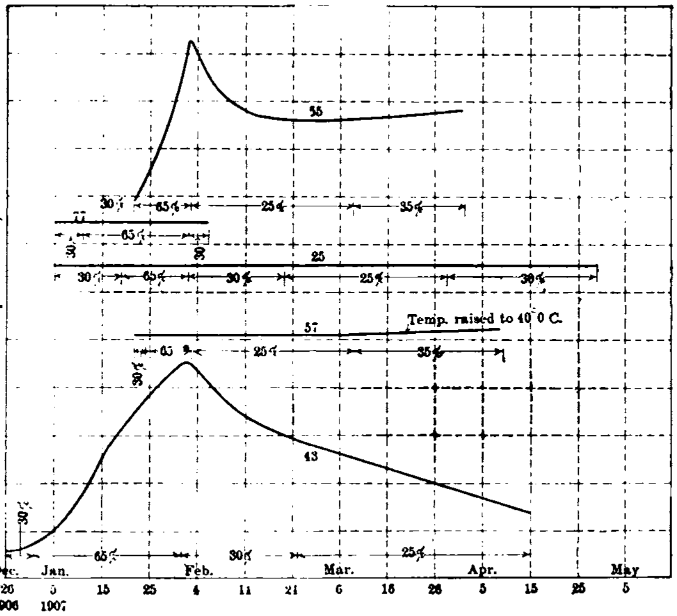


FIG. 6.—DIFFERENCES IN BEHAVIOR OF COILS WOUND ON WOODEN SPOOLS.

The curves of Fig. 6 show the differences in the behavior of resistances of manganin coils, all of which were wound on wooden spools, and kept in an atmosphere of different humidities, but with different methods of preparation or of mounting.

Curve 55, 1000 ohms, wood spool thoroughly shellacked and baked, no shellac on outside of wire, no baking of wire.

Curve 57, 1000 ohms, same kind of wire wound on similar wood spool, latter boiled in paraffin, no paraffin on wire, no heating of wire.

Curve 77, 1000 ohms, on wood spool, wire and spool shellacked and baked, and then coated with paraffin.

Curve 25, 1000 ohms, on wood spool, wire shellacked and baked, and coil then sealed in a test tube by means of a cork and hot paraffin.

Curve 43, 1000 ohms, on shellacked wood spool (several coats), wire shellacked and baked after winding. Unifilar winding.

number of such working standards of resistance with very slight expense or trouble, and may have them compared at a standardizing laboratory more frequently than the bulkier and more expensive standards that have heretofore been thought necessary. We are developing some new forms of sealed standards which will be small enough to be sent through the mails.

## Induced Draft in the Boiler House.

In a paper by an English author, on "Notes on the Application of Induced Draft," reference was made to one case in particular of five boilers fitted with steam jets, which resulted in a coal consumption of 27.3 lbs. of coal per square foot of grate, the evaporation from and at 212 deg. being 9.8 lbs. of water per pound of coal, with a temperature of the economizer water of 166 deg. With induced draft the results obtained were as follows: Coal consumption per square foot of grate, 25.4 lbs., evaporation of water, 10.2 lbs. per pound of coal, and temperature of economizer water, 259 deg. Taking measurements of the electrical output of the plant, it was found that, using the steam jets, for each unit of electricity 3.6 lbs. of coal and 30 lbs. of water were consumed. With induced draft the results were 3.1 lbs. of coal and 28 lbs. of water per kw-hour. In this case 1800 gallons of water were simply evaporated for use by the steam jets. The net saving in this case worked out at 14½ per cent.

## Experiments with Concrete Telegraph Poles.

BY G. A. CELLAR.

In a paper under the above title read before the convention of the Association of Railway Telegraph Superintendents, at Atlantic City, June 19-20, Mr. G. A. Cellar, superintendent of telegraph of the Pennsylvania Lines West of Pittsburg, gave an account of some investigations made into the subject of preservatives for telegraph poles. The treatment of the entire pole was too expensive in proportion to the benefit thus derived, so it was decided to apply the preservative only to that portion of the pole extending 1½ ft. to 2 ft. on either side of the ground and air line. That the result justified the expense is borne out by the present condition of the poles so treated. Mr. Henry Grinnell, Assistant Forest Inspector of the Department of Agriculture, in a report of experiments of this character concludes that the application of preservatives to poles by means of brushes is so cheap that the cost is balanced by an increase of eight months in the life of the pole. As to steel poles, they are no more durable than the long-lived woods unless properly protected by preservatives. The inside as well as the outside of a steel pole open to the air should be accessible for the pur-

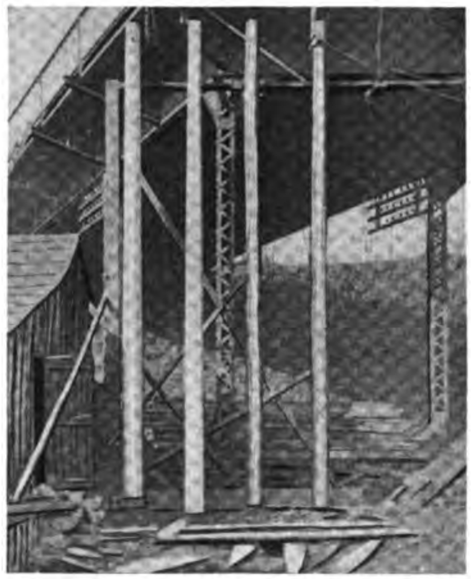

FIG. 1.—POLES READY FOR TEST.

pose of inspection and reapplication of preservatives. In the author's experience, the preservation of steel imbedded in properly constructed concrete is perfect, and a telegraph pole made of reinforced concrete has a life that is practically unlimited.

Mr. Cellar then gave the results of experiments made by the Pennsylvania Lines West of Pittsburg with concrete poles. These results, however, are not presented as final, but rather more in the nature of a report on progress. Two hollow poles were made and tested, the object of this form of construction being to secure requisite strength with the minimum weight. One of the patterns was square in section, with the corners chamfered off; the other, octagonal in section, and the hollow space extending from the base for about two-thirds of the length of the pole, the upper third being solid, and the walls of the lower two-thirds being from 1¾ in. to 3 in. thick. These poles weighed approximately 3500 lbs., and were calculated to withstand any stress in any direction that could possibly be imposed upon them by a line of 50 wires, each wire coated with sufficient ice to make it 1 in. in diameter. The tests were made in connection with two carefully-selected cedar poles of the same length (30 ft.), and all were set in concrete, the bases being 3 ft. x 3 ft. x 5 ft. deep.

Just within the outer surface, the walls of the concrete poles were reinforced with iron rods, which consisted of four ¾-in. round bars, each 24 ft. long and four ⅝-in. round bars of the same length. The poles were 8 in. in diameter at the top and 13 ins. at the base, having a taper of 1 in. in 5 ft. Galvanized iron steps were screwed into wooden blocks molded into the concrete and holes were left for through bolts for supporting the cross-arms. The cross-arm braces were attached to the arms by through bolts in the same manner and fastened to the poles with ordinary lag bolts driven into wooden plugs which were placed in the concrete at the proper places. After standing long enough to permit the cement to become solid, the four poles were tested in turn for ultimate deflection. The results of the tests are shown in the accompanying table:

| Pole. | Pull at Top Pounds. | Deflection at Top Inches. | |
|---|---|---|---|
| Octagonal concrete..... | 3030 | 11¾ | Cracked in two places. |
| " " ..... | 3430 | 14¼ | Two other cracks. |
| " " ..... | 3210 | 18 | One more crack. |
| " " ..... | 3150 | 25½ | Broke at ground level. |
| Square concrete........ | 3430 | 34½ | One crack. |
| " " ........ | 3690 | 39 | Three more cracks. Pole crushed crack at ground level. |
| White cedar No. 1..... | 2530 | 47 | Pole broke. |
| White cedar No. 2..... | 2870 | 35 | One crack. |
| " " " ..... | 3494 | 66 | Pole broke. |

After the cement poles had been broken, the reinforcement so held them that it required almost the breaking pressure to

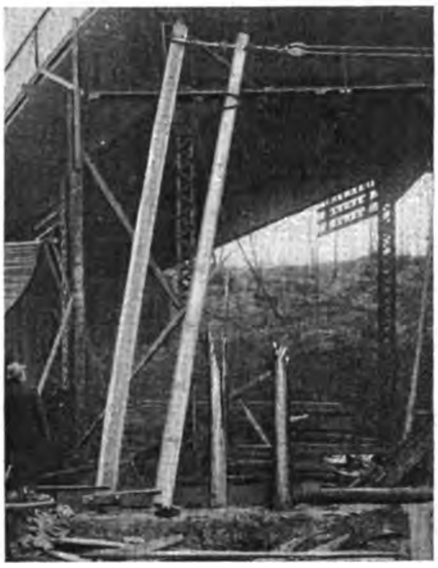

FIG. 2.—END OF TEST.

further deflect them from their slightly inclined position. The wooden poles under strain presented the form of an arch before breaking, and when they gave way were fractured completely; but these features were lacking in the cement poles, which were very firm and did not give until they began to crush at the ground line.

The argument has been advanced that the reinforced cement pole would be very liable to damage or disruption by shock, but the fact that concrete piles, both of hollow and solid designs, are driven by pile-drivers, and especially with the knowledge of the experiments at Rochester, which showed that the poles, even after they had been fractured at the surface of the foundations, required an extremely heavy pressure to produce further deflection from the positions at the time of fractures—in other words, that they were almost as stiff as when they stood upright, and continued to be so throughout the entire test—the author felt that any alarm at the prospect of damage by collision beween the pole and anything less than a movable object that would destroy any pole of natural or manufactured composition is unfounded.

As to the insulating qualities of the concrete pole, the author stated that they were superior to those of any other pole manufactured in this country.

Continuing experiments already made the company will soon set some steel poles with just enough concrete to serve as a preservative and other steel poles covered with a cement paint. The concrete poles used in the above tests were made and tested in the yards of Robert A. Cummings, at Rochester, Pa.

## Niagara Convention of American Institute of Electrical Engineers.

As we go to press the annual convention of the American Institute of Electrical Engineers is in session at Niagara Falls, and below are given abstracts of such of the papers of the programme as were printed in advance. An account of the earlier sessions appears elsewhere. including abstracts of the discussions on the papers presented before these sessions.

### THE PROPERTIES OF ELECTRONS.

The presidential address of Dr. Samuel Sheldon dealt with the properties of electrons as viewed from the standpoint of the electrical engineer. He stated that electrons are the smallest particles of matter that have been isolated. They are present in metallic conductors, in gases, especially at low pressures, and to a limited degree in ordinary solid dielectrics. They are not present in free ether or space. Their properties are in no wise dependent upon the properties of the matter with which they are associated, and they are considered to be indestructible by any agent within the command of man.

The address dealt with the determination of the charge, the mass, and the size of the electron. The production of positive and negative ions was also treated in detail. The relation between the metallic conduction of heat and the metallic conduction of electricity was discussed in view of the knowledge of electrons. Thus, with few exceptions, the thermal and electrical conductivities of pure metals, when at proper temperatures, depending upon the metals, bear a constant ratio to each other. The only satisfactory explanation for the constancy is the one which assumes that both electricity and heat are conveyed by electrons, the one under the influence of the e. m. f. and the other under the influence of thermomotive force. Expressions were given for the values of the contact e. m. f. between two metals, the thermal e. m. f. between two junctions and e. m. f. induced electromagnetically. The Hall effect, which relates to the distortion of the current in a metal sheet when subjected to a magnetic field perpendicular to the sheet, was explained from the standpoint of the electron theory. It was stated that to free electrons may be attributed the conductivity in solid dielectrics that remains after surface leakage has been prevented. After discussing the relation between the phenomena of the electrons and the production of light, black-body radiation, selective radiation and luminescence, Dr. Sheldon concluded that although much is known concerning the size and mass of the electron, its electric and magnetic effects when in motion, and its radiation effects during acceleration, little more is known concerning its structure than that "it is the intrinsic strain-form alone that constitutes the electron; and it is a fundamental postulate that the form can move from one portion to another of the stagnant ether somewhat after the manner that a knot can slip along a cord."

### THE HEATING OF COPPER WIRES BY ELECTRIC CURRENTS.

A paper by Dr. A. E. Kennelly and Mr. E. R. Shepard discussed at great length a theoretical and experimental investigation of the heating of copper wires by electric currents under various conditions. From their researches the authors drew the following conclusions:

1. The fundamental formula for the direct current final heating of a wire that cools by thermal conduction is $\frac{\theta}{1 + a\theta} = K I^2$ where $K$ is a constant for the wire determined by the total linear thermal resistance, $\theta$ being the temperature and $a$ a constant. This formula applies to concealed wires; that is, to insulated wires in water in the ground or in wooden moulding.

2. The thermal resistivities of the various substances tested with different temperature elevations, including rubber composition braiding, moulding and various oils may for practical purposes be regarded as constant. That is, not appreciably affected by temperatures up to 100 deg. C.