not desirable to open a circuit immediately, for example, an overload of very short duration on an important feeder might not be harmful, and yet be decidedly dangerous if of a few seconds' duration. The bellows type of relay, a diagram of which is shown in Fig. 201, is designed to control an oil switch in this manner. The bellows is at the top and when the iron core of the solenoid is actuated by the coil it can move but slowly because of the slow escape of the air from the bellows. As the solenoid is drawn in the bellows moves upward and the operating-circuit terminals below it are closed.

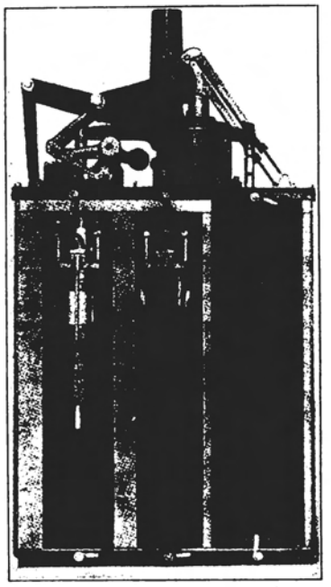

FIG. 200.—HIGH-TENSION OIL CIRCUIT-BREAKER, SHOWING OIL TANK AND CONTACTS.

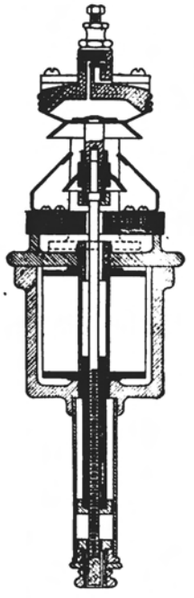

FIG. 201.—TIME-LIMIT OVER-LOAD RELAY.

The inverse time-limit relay is so arranged that the retarding action varies inversely with the current flowing, so that the greater the current the quicker the relay will respond. Relays are also made that open the switches when the line current, or one phase of it, reverses. The use of various kinds of relays permits the use of simple oil switches that may be opened at will or automatically under various abnormal conditions.

*Switchboard design.*—The design of a switchboard is a problem to be worked out for each installation. There are many items to consider and a wide range of selection as to instruments and methods of connection. Among the desirable features to be observed in laying out a switchboard are: Accessibility of all parts, fireproof construction, keeping live parts from the front of the board, simple and "foolproof" arrangement of circuits, provision of abundant protective devices, as well as indicating and recording instruments for proper operation of the units and for recording their output. Many of these points have been touched on already.

The multitudinous possible arrangements of circuits, switches and instruments in a switchboard is a subject very large in itself and beyond the scope of this series of articles, which have attempted to give only an outline of the general principles involved in the generation and utilization of the alternating-currents most commonly employed at the present time.

[THE END.]

## Lights Controlled by Wireless.

The recent Omaha Electrical Show was lighted through wireless telegraphy during one evening, the first time that a large lighting current has been controlled without wires. The system is a discovery of Dr. Frederick Millener, wireless expert of the Union Pacific.

Four thousand incandescent electric lamps were controlled from a wireless telegraph station at Fort Omaha, five miles from the building. A dozen times during the evening Dr. Frederick Millener turned on and turned off every light in the big building from his station.

The current, as sent out from the Government wireless station at the fort, was picked up by the antennæ on the roof of the Electrical Building. From this it passed to a coherer, which in turn set the current to energizing a four-ohm track relay. This relay closed a circuit solenoid switch, thereby turning on a seventy-five horsepower current and the lights flashed on.

## Electrification of Railways.

The question of the further electrification of the New Haven Railroad is receiving the earnest attention of the officials. The electrification of the New Haven from the Harlem River to Stamford, Conn., cost $5,000,000 in round figures, and the operation has been sufficiently successful to warrant an extension of the service.

It is now planned to increase the installation for passenger traffic from Stamford to New Haven, a distance of thirty-nine miles; also to increase the installation to provide for the electric operation of freight trains between New Haven and the Harlem River, as well as the electrical equipment of the branch running between New Rochelle and the Harlem River for both freight and passengers.

The total cost of such additional installation is placed by electrical engineers at about $12,000,000.

The question of the saving in operating costs of electricity, compared with steam, is still a debatable one, though the best estimates would indicate a saving in favor of electricity equal to between four per cent and five per cent on the total cost of installation of $17,000,000, this latter figure including the cost of the present installation between Harlem River and Stamford.

This saving alone might not justify such a large expenditure were there no other factors to be considered, such as increased business, ability to handle a larger business to better advantage and the general convenience of not only the traveling public, but the general public as well, by reason of the absence of dirt, smoke and excessive noise.

## A Broad Charter.

Last week a charter to operate a neighborhood line was granted the Effingham Telegraph and Telephone Company of Effingham, Ga. Occasion was taken in the charter application to reserve the privilege of establishing a continental system of telephones. The incorporators ask that they not only be authorized to install a local system, but be given the right to extend it into all the towns, cities and counties of Georgia and into all the cities, towns and counties of all the other states or territories of the United States, including the District of Columbia. The capitalization is $5,000.

It is understood that the company does not intend doing a cable business, or "island possessions" would have been included in its field of possible operation.