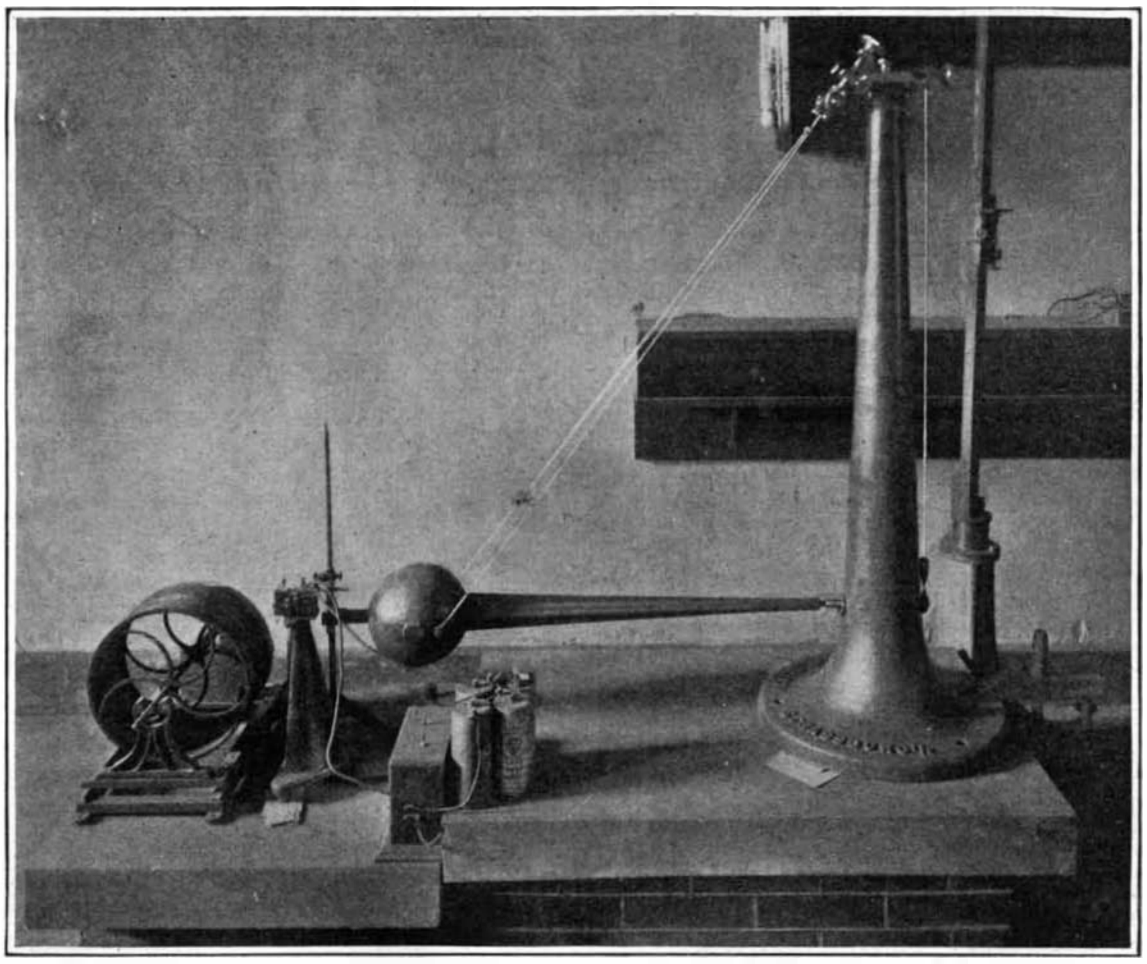
FEELING THE EARTH'S PULSE.

The land on which we live and build our houses—the land, which the sea-writers of the early part of last century confidently and almost affectionately termed *terra firma*—is well nigh restless as the ocean which washes its shores. Even in the north some seventy unfelt earthquakes, each having a duration varying from twenty minutes to several hours, may be recorded yearly. Our buildings rock and sway, if we could but see them, as the masts of a ship on a heaving sea. To be sure, the incessant rising and falling of the waters is more violent than the motion of the land. But the difference between the two is largely a difference of effect—the difference between a billow and a ripple.



General View of the Weather Bureau's Seismograph.

We, who live far north of the equator, never perceive the feeble tremors of the earth beneath our feet. But the man who spends his life in studying the movements of the land, great and small—seismologist he calls himself—knows better.

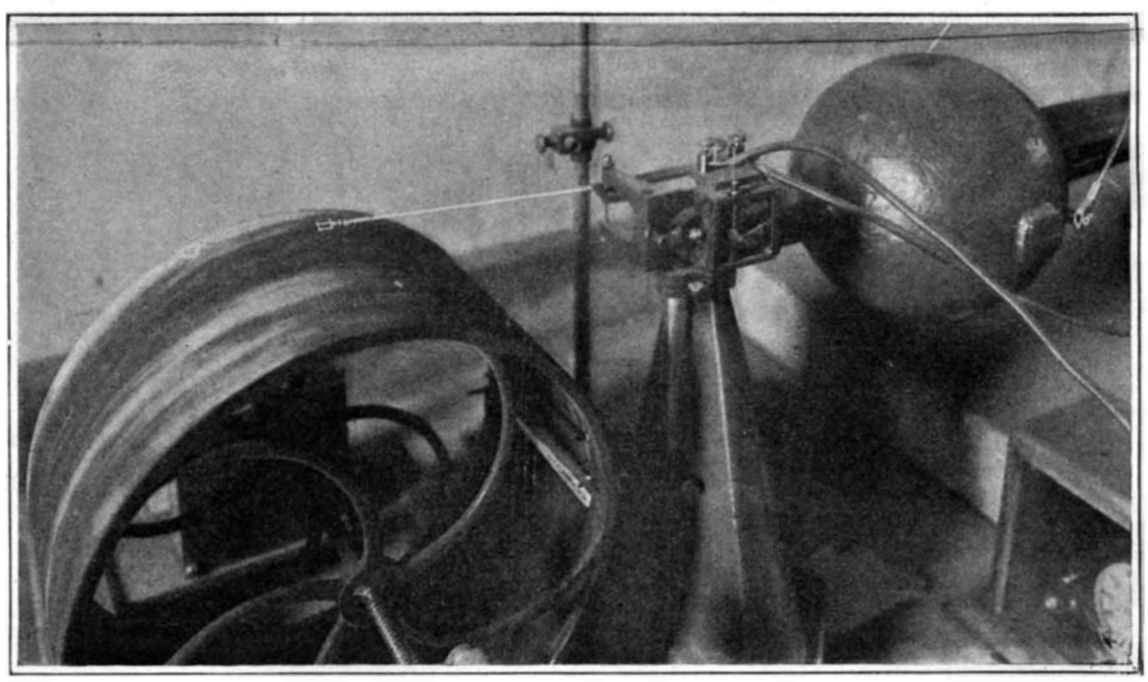
The seismologist knows that the earth throbs, not because he has better eyes than other people, but because he has devised wonderfully ingenious instruments, so highly sensitive that they tremble as the earth trembles, and thus enable him, as it were, to feel the earth's pulse. And with the help of these delicate instruments, he can tell us how large, or rather how small, are the ripples that play over the earth's surface. Some day when more seismological stations are established throughout the world, when more seismological records have been gathered, and when some master mind will burst forth whose grasp is so broad that it can embrace many isolated scientific facts that now apparently have no connection, we may even know what earthquakes really are and by what they are caused. When that scientific millennium comes, the earthquake-prophet will appear in the land and tell us when and where we may expect the next volcanic eruption or upheaval of the earth.

It must be confessed that the theories of the origin of volcanic eruptions and of earthquakes, with which science has so far furnished us, are more picturesque than useful. About one hundred and fifty years ago a Cambridge professor, John Michell, advanced the remarkable theory that the earth's crust constituted but a shell, the interior of which was a liquid body. He thought that this interior liquid was in some inexplicable way lashed into waves, just as a carpet becomes a billowy mass when shaken by one corner; and that such waves shook the earth's crust and produced earthquakes. For a century and more that theory, modified slightly to suit newly-discovered facts, has been paraded in every school and college that professed to teach anything at all of geology. Modern physicists, however, have contumeliously knocked Michell's theory on the head. We are almost ashamed now that we ever believed it. With the fate of Michell's doctrine before them, scientists have been loath to advance new ideas. Nevertheless, an English geologist of note had the courage to believe that earthquakes were due to "the snap and jar occasioned by the sudden and violent rupture of solid rock masses, and perhaps the instantaneous injection into them of intumescent molten matter from beneath." That seems bewildering enough to be true. But the "intumescent molten matter" theory has also been laid at rest. Well aware of the enormous expansive force of steam, some students of earthquakes have not hesitated to attribute such violent eruptions as we have recently witnessed at Vesuvius, to water which has found its way down into the earth and come into contact with highly heated masses of rock. The theory is at least plausible. But it has been sharply assailed by well-informed critics.

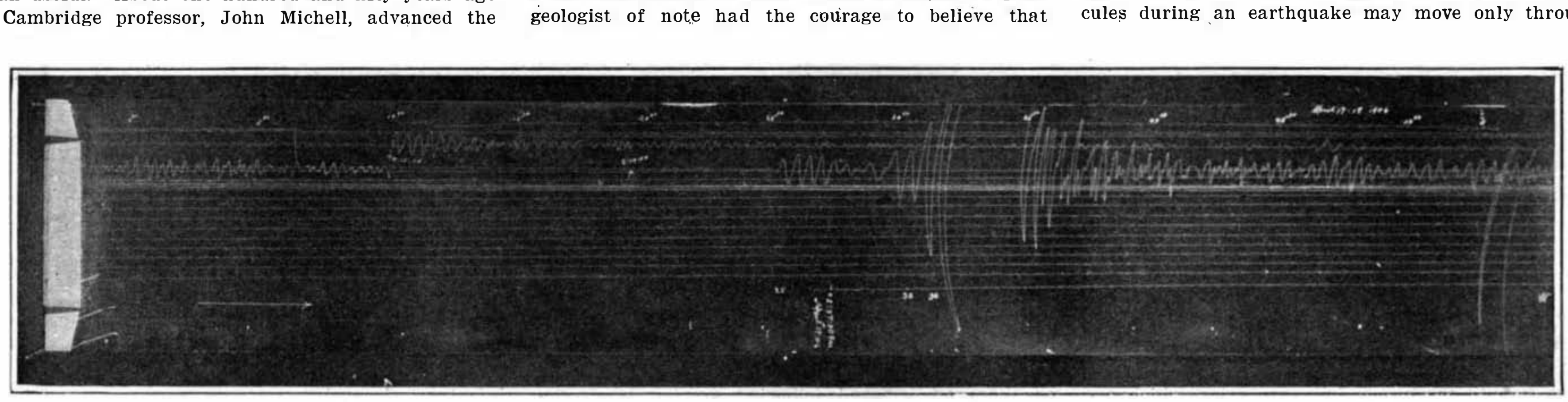
After all this indiscriminate theorizing, it must be confessed that but little progress has been made in furnishing an adequate explanation of the origin of earthquakes and volcanic disturbances. Seismologists have succeeded in establishing simply the fact that the occasional displacements of the earth's crust are due to the sliding, crumpling, bending, and cracking of rocks. The origin of such a disturbance may be best described as a wrench, which, when analyzed, is found to consist of a pull and a twist. This wrench both compresses and distorts. It gives rise to two waves—a wave of compression and a wave of distortion—which travel with different velocities. Rock, like most bodies, tends to return to its original volume, after compression, by virtue of its elasticity. To the forcing together and springing apart of the rock molecules is due a wave of longitudinal displacements—one of the two waves mentioned. The rigidity of the rock gives rise to a wave of transverse displacement—the other of the two waves.

If an earthquake be simply the result of wave motion, an inquiring man might ask: How comes it that only certain places experience the shock, and not all those along the line of the wave?

A distinction must be drawn between the movement of the wave and the movement of the molecules of rock through which the wave travels. The pulse of the wave may be propagated to a vast distance; and yet the excursions of the rock molecules are confined within narrow bounds. Imagine a long row of marbles, placed on a table, the one touching the other. If a shock be imparted to the marble at one end of the row, the marble at the opposite end will leap out of its place; but the intermediate marbles will scarcely move at all. The wave was transmitted through its entire row, but only where it broke was the shock felt. Thus is the shore battered by sea-waves; thus is the earth heated by the breaking of light-waves sent by the sun; and thus it happens that such rock-molecules during an earthquake may move only through



Detail of the Stylus and Recording Drum.



Record of San Francisco Earthquake Made by Weather Bureau Seismograph, Showing that the Shock Was Felt at Washington at 8:20 A. M., April 18, 1906.

THE EARTH'S AUTOGRAPH.

a few inches, while the undulation may travel for hundreds of miles. The distance through which the individual molecules oscillate is called the "amplitude" of the wave.

With the effect of a seismical wrench determined, the next step is to invent some means of detecting and recording the waves, felt and unfelt, to which that wrench gives rise. Such means are primarily of importance for the purpose of determining the path of the wave. Naturally, the waves that can be felt are those most easily recorded. Every object that has been visibly affected by a seismic disturbance is a recorder, to a certain extent. Fractures and fissures in walls rent by an earthquake are of inestimable value to the seismologist, because they often indicate the direction in which the waves emerge at the surface and the manner in which they break. The simplest of all recorders, one which has been used in Japan for over twelve hundred years, is a lamp, which, when overthrown, is extinguished. Still another form of recorder, simple as it is rude, consists of a vessel containing some syrup-like liquid, which rocks as the earth rocks, and leaves its mark—a rough indication of the direction and extent of seismic motion. A device much used in Italy comprises a tray, formed in its sides with recesses which are filled to the brim with mercury. When the earth trembles, the mercury is spilled into small cups, hung beneath the recesses. By measuring the amount of mercury retained by the cups,

(*Continued on page* 346.)

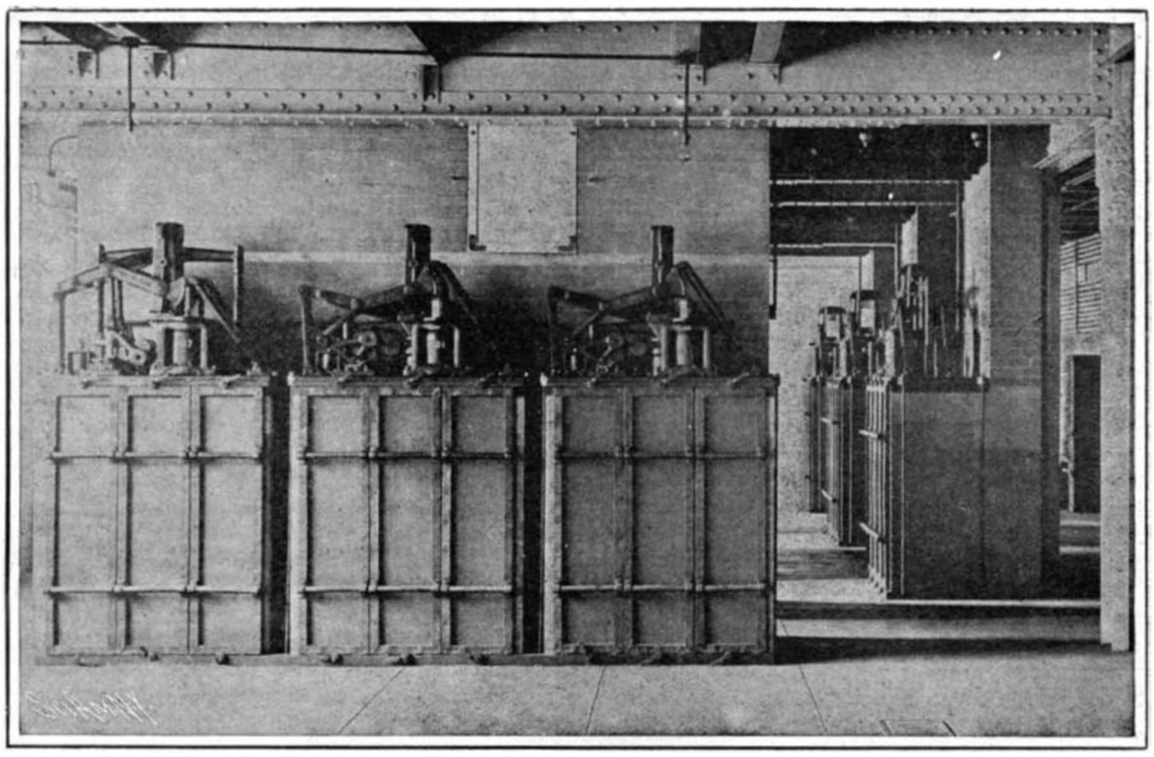


Fig. 4.—Feeder Gallery, Showing Type Coil Circuit Breakers for Feeders and Generators

ELECTRICAL EQUIPMENT OF THE LONG ISLAND CITY POWER STATION.

In our issue of April 7 we published an illustrated article on the Long Island power station of the Pennsylvania, New York, and Long Island Railroad, which dealt with the building, coal-handling plant, turbines, and generators. In the present article we give some details of the electrical equipment of the installation, which will be of interest.

A somewhat unusual feature has been introduced into this station, to prevent the serious deterioration usually occurring where salt water is used for circulation in surface condensers. It is the universal experience that more or less galvanic action at the expense of condenser tubes takes place in any event, but this is often aggravated in large and important plants by the fact that the water and the body of the condenser have formed a convenient path for stray electric railway return currents getting back to their own power station some distance away through the condenser intake and the water of the harbor. In the case under discussion a sufficient number of voltmeter readings was taken between the river, the flume, and various parts of the piping about the building and in the streets to indicate that there was at all times difference of potential sufficient to make trouble, notwithstanding that its polarity was not always the same.

The metallic connections of the power station equipment to the city piping station are through two 14-inch connections to the water main; and on ac-

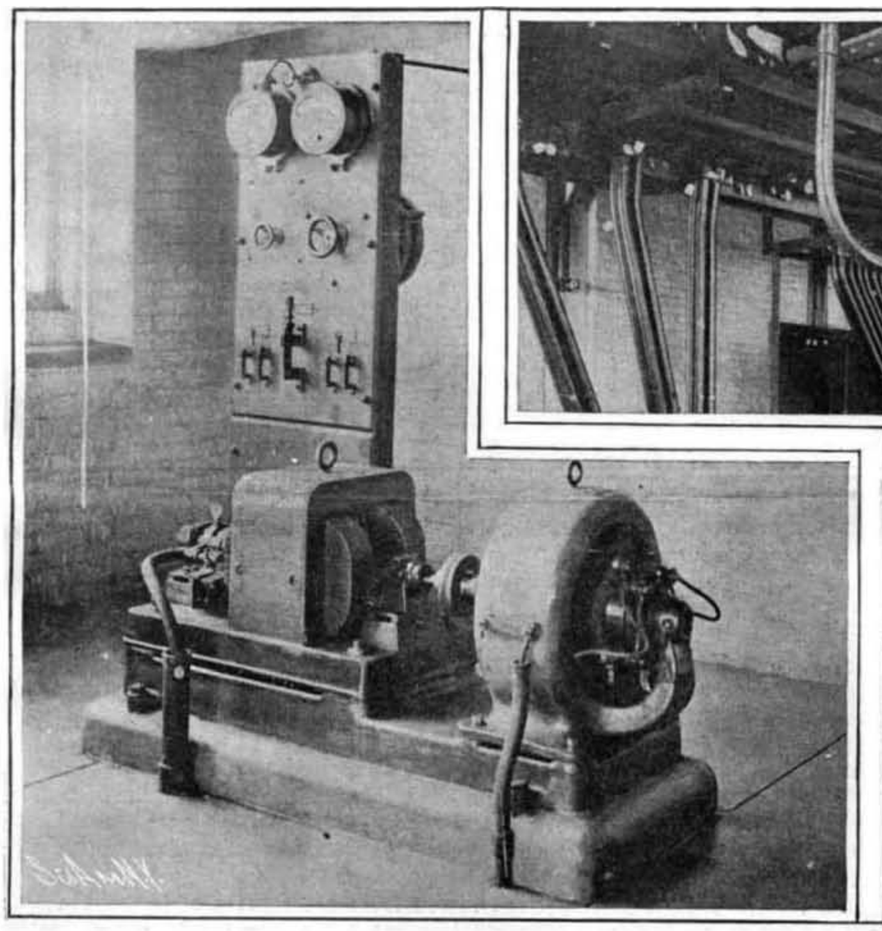


Fig. 1.—Booster for Preventing Condenser Electrolysis

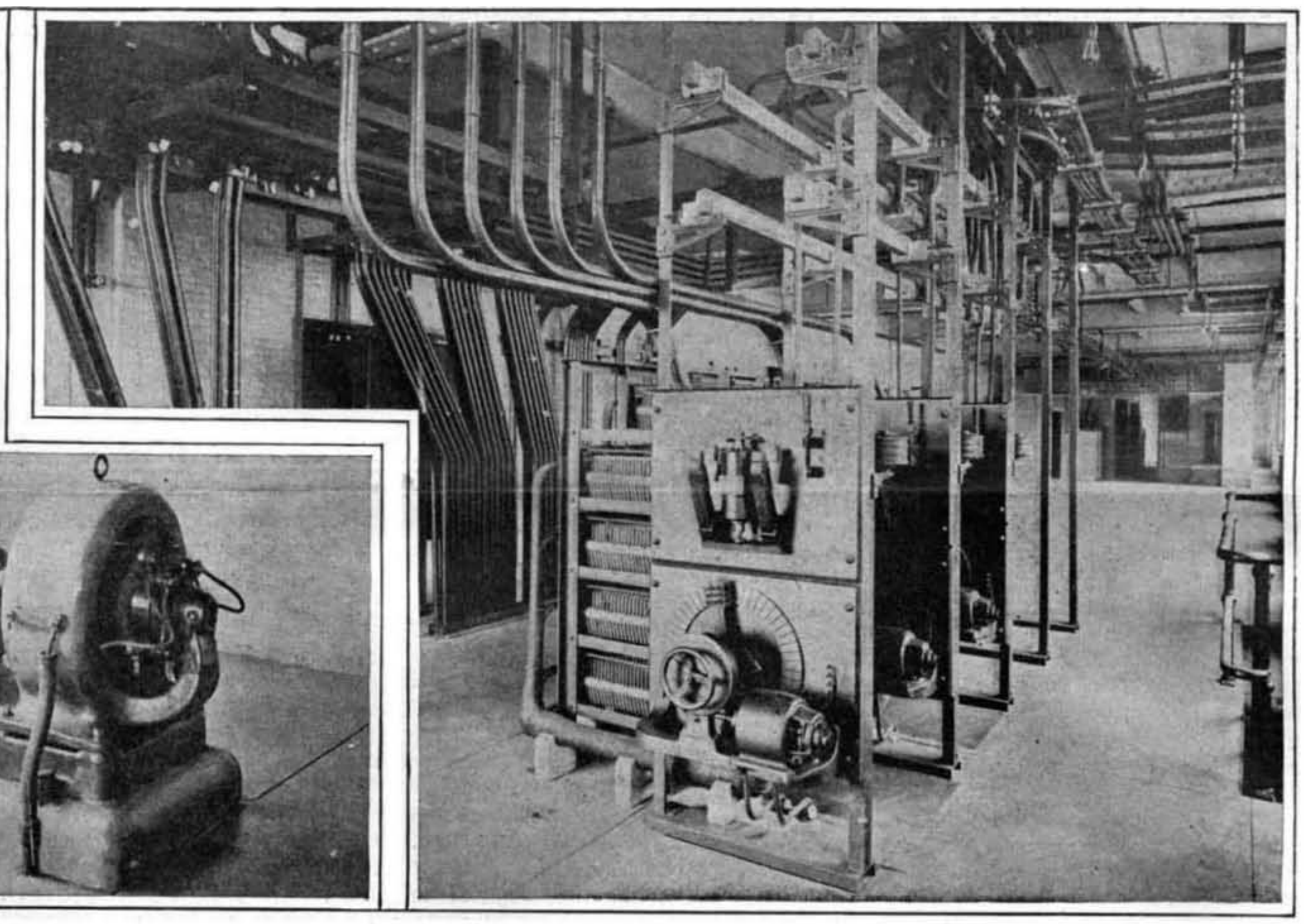


Fig. 3.—General View of Bus Gallery, Showing Main Generator Rheostats and Auxiliary Wiring.

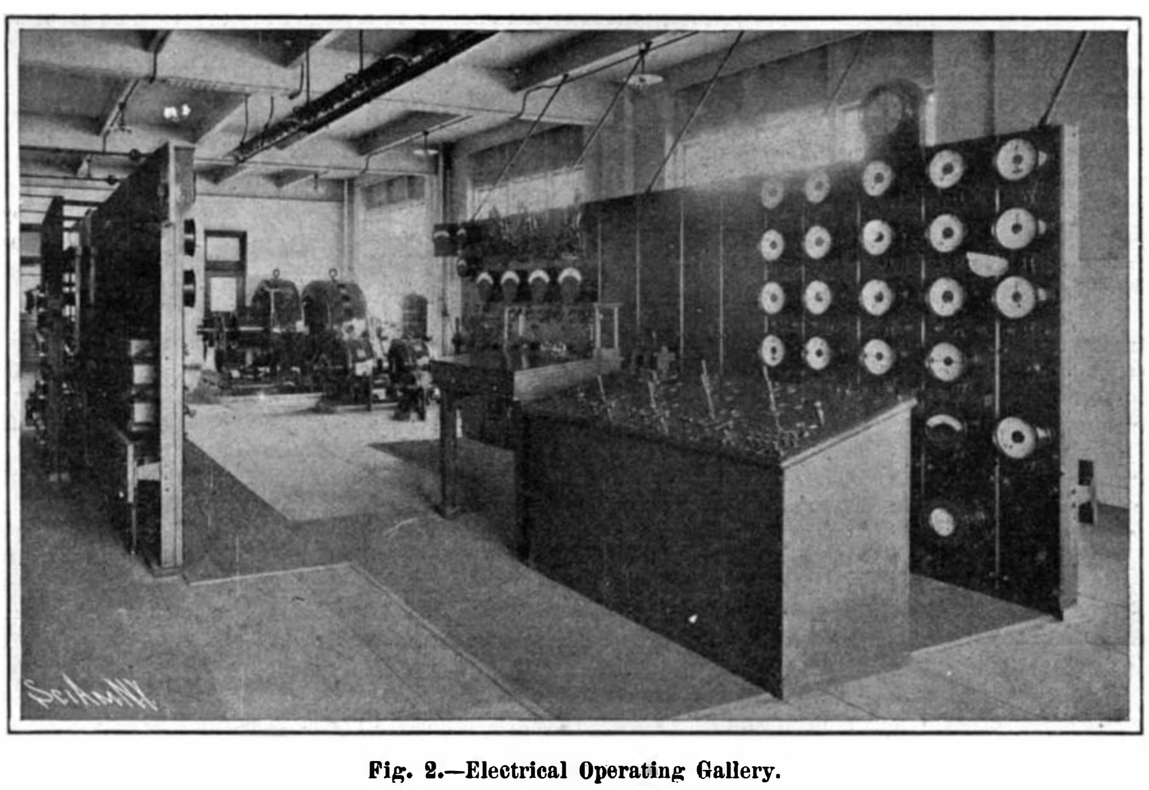


Fig. 2.—Electrical Operating Gallery.

ELECTRICAL EQUIPMENT OF THE LONG ISLAND CITY POWER STATION.