

Fig. 1.—A typical load curve of a lighting central station for a normal summer day (1913).

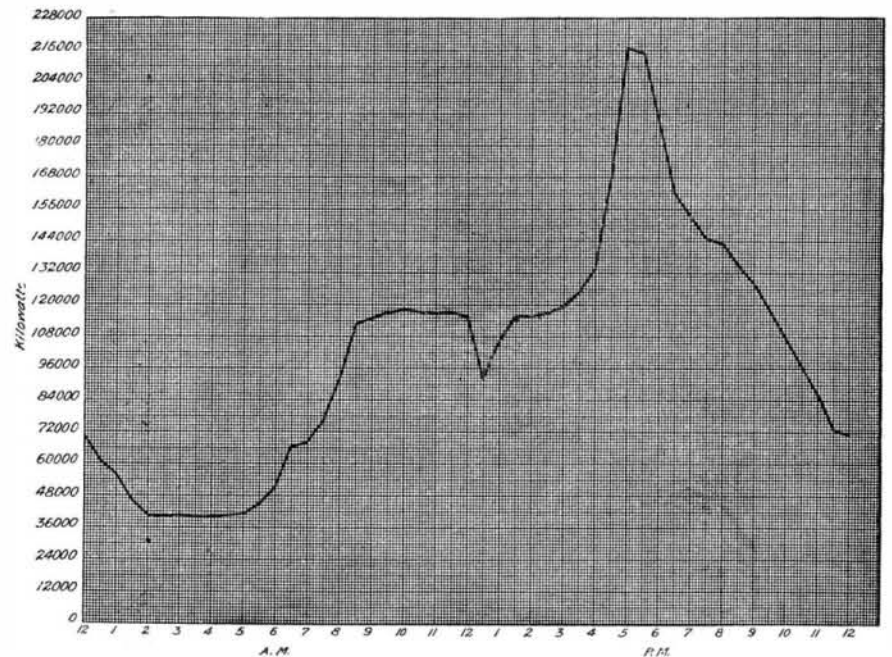


Fig. 2.—A typical load curve of a lighting central station for a normal winter day (1913).

The Storm Detector*

Its Influence Upon the Operation of Lighting Central Stations

By W. H. Lawrence

INTRODUCTION.

SUCH public utilities as those supplying gas and water are fortunate in that the commodities they distribute are physical materials. During those parts of the day when the demand for their product is small, the excess delivered from the station can be economically stored in a reservoir for use at later periods in the day when the demand is greater than the capacity of the station.

The public utility that distributes electricity, however, cannot be modeled profitably after this plan on account of the properties of the commodity that it handles.

Electricity, like light and sound, is not a physical material and therefore can exist only as long as the influence of its generating source continues. This property renders it impossible to directly store or preserve electricity for future use. Although such an end may be indirectly accomplished by the use of storage cells, which convert the kinetic energy carried by the current into potential chemical energy and later carry out the reconversion, the efficiency of this method is very low. For this reason, the use of storage batteries in supplementing the generation of electricity has been restricted to such purposes as involve the furnishing of a reserve to safeguard the service against interruption when some accident temporarily affects the generating, transmission or transforming systems.

Electrical stations, being unable to economically avail themselves of the use of a reservoir which may be charged with the excess energy of the station at light-load periods and discharged to assist the station at the heavy-load periods, have to be designed with a capacity equal to no less than the maximum demand upon them. This factor of an installed station capacity at least equal to the maximum peak load is the greatest financial handicap to which an electrical station is subjected. That this condition is unavoidable has long been recognized and accepted by our business men and engineers.

The variations in the load which are demanded of a lighting station during the day and the characteristic difference between the summer and winter loads are shown by Figs. 1 and 2, of which Fig. 1 is a typical load curve for a summer day and Fig. 2 one for a winter day. (A typical load curve for the month of March is shown in Fig. 3. It will be noted that the time at which the peak occurs lies between the hours of the winter and the summer peak.)

Since it is only during the peak load of the day that the whole equipment of the station is working, it is evident that the return on the entire investment during the remainder of the day must be earned by that portion of the equipment that is then operating.

This is a condition that makes it highly imperative that an electrical station be operated with maximum economy throughout the entire day. Given a certain station equipment, this is mainly accomplished by a strict adherence to a regular daily routine. Thus, at any period of the day only that number of machines is operated which is sufficient to economically carry the load then existing. At times of light load or average load, a steam-driven station will have a large share of its boilers "banked" and a number of its generating units idle. When under such a condition a large unexpected demand for an increased output may be made so sud-

denly that the number of machines which are operating will be insufficient to carry the abnormal demand, and it is probable that the standard of service will be lowered until such time as reserve boilers and generating units can be brought into service. For this reason it is imperative that the station receives preparatory warning of any abnormal demand.

The rapidly moving clouds which accompany a storm constitute the principal cause for the sudden and unexpected increases in the demand for current from a lighting station. The effect which a sudden and heavy storm may have upon the station's output is shown by the sharp peak at the 3:35 P. M. point of the curve in Fig. 4. This is the record of an actual occurrence which took place during the month of March, 1911. It will be noted from this curve, and by a comparison with that of Fig. 3, that the demand at 3:35 P. M. is 73 per cent greater than it would have been had there been no storm. An increase of 49,500 kilowatts, in this instance, was called for in about five minutes, which gives a good idea of the severe demands that may arise and which a lighting station must be prepared to meet.

Any device, therefore, that will provide a warning of the approach of a storm, at a time sufficiently far in advance to enable the station attendants to prepare for the exception to their daily routine in a deliberate and orderly manner, would be most welcome.

The storm detector is such a device.

STORMS AND THEIR EFFECT ON THE DETECTOR.

All summer storms, or practically all of them, are accompanied by electrical disturbances in the ether. These cover a field far greater than that over which the storm clouds themselves are visible. By use of antennæ, some of these radiations may be intercepted and by a suitable apparatus be made to give an indication of not only the presence but also the relative proximity of the storm.

The storms that occur during the winter months are usually snow storms and are of but a weak electrical nature. For this reason, they may perhaps not affect the device. At this season, that is a matter of but small moment. In winter the load upon the stations during the daylight hours is uniformly greater than during the summer, and the demand regardless of the severity of the storm will always be from 20 to 25 per cent less than the demand which occurs daily between 5 and 5:30 P. M., for which the station is always prepared.

This is evident when it is considered that winter storms have no effect on street lighting and other outside lighting, sign lighting, residence and apartment-house lighting, etc., all of which are on at the time of the daily peak at 5 P. M. For this reason, winter storms are of such minor importance that the service of the storm detector is dispensed with during that season.

DESCRIPTION OF STORM DETECTOR.

The various parts making up the detector are an aerial, a short-circuiting switch, a spark gap, a coherer, a relay and battery, a bell (which also acts as a decoherer) and battery, a condenser and a ground connection. Fig. 5 shows the diagram of connection of these parts.

Aerial.—Antennæ, similar to the more simple ones used in connection with wireless telegraph outfits, have

been found to serve the purpose admirably. It is this part of the equipment that receives the ether radiations resulting from the storm.

The oscillating current thus set up travels to and from the ground through the spark gap, coherer and condenser.

Short-circuiting Switch.—This switch and its connections are shown in Fig. 5. Nominally, it is kept in the "open" position. After the alarm bell has begun to ring continuously, it is closed to protect the apparatus from heavy surges and to silence the bell.

Spark Gap.—This consists of a simple gap with spherical terminals placed approximately 1/64 inch apart. The purpose of this gap is to prevent those surges that are induced in the antennæ by the radiations emanating from wireless telegraph stations, but which are very weak as compared to the lighting disturbances, from flowing through the remainder of the apparatus and thus causing a false alarm.

Coherer.—This is also patterned after the type of the simple ones used in the early days of wireless telegraphy. In brief, it consists of a short section of glass tube of small bore loosely filled with nickel-silver filings. These are connected at each end to the outside circuit by German silver plugs. The action of such a type of coherer is well known, and needs no further explanation than to say that it acts as a high resistance to the low-voltage battery current impressed upon it until a high-frequency discharge current, between aerial and ground, has passed through it. This high-frequency current effectively lowers the coherer's resistance to the battery current, which consequently allows a greatly increased battery current to flow through the tube. The resistance of the tube then remains unchanged until it is violently jarred, at which time the high-resistance property returns.

Relay and Battery.—The most effective type of alarm is an audible one, of which the simplest form is a bell. However, as a bell requires a greater amount of current for its operation than that increased amount of battery current which is caused to flow in the coherer by a high-frequency discharge, some magnifying or relay device must be used. The relay employed is one of the ordinary telegraph type and the battery *B*₁, Fig. 5, is of dry cells. The connections are given in Fig. 5.

Bell and Battery.—The bell is one employing single-stroke connections and is of a size sufficient to be easily heard throughout the system operator's office. (The coherer, relay, condenser and bell are located in this office.) The bell has its own supply battery of dry cells, *B*₂, and is controlled by the secondary contacts of the relay, as shown in Fig. 5.

As the low-resistance condition into which the coherer is thrown by a high-frequency discharge is permanent until the tube is severely jarred, the bell is mounted so that its clapper will strike the tube and thus perform the two-fold function of bell and decoherer. (It is evident that the tube must be decohered, otherwise it would not show the effect of a later high-frequency discharge.)

Condenser.—The condenser is an ordinary one and is inserted in the ground wire to prevent stray direct current from flowing in the apparatus.

Ground Connection.—This connection completes the high-frequency circuit from aerial to ground.

* Reproduced from the *General Electric Review*.

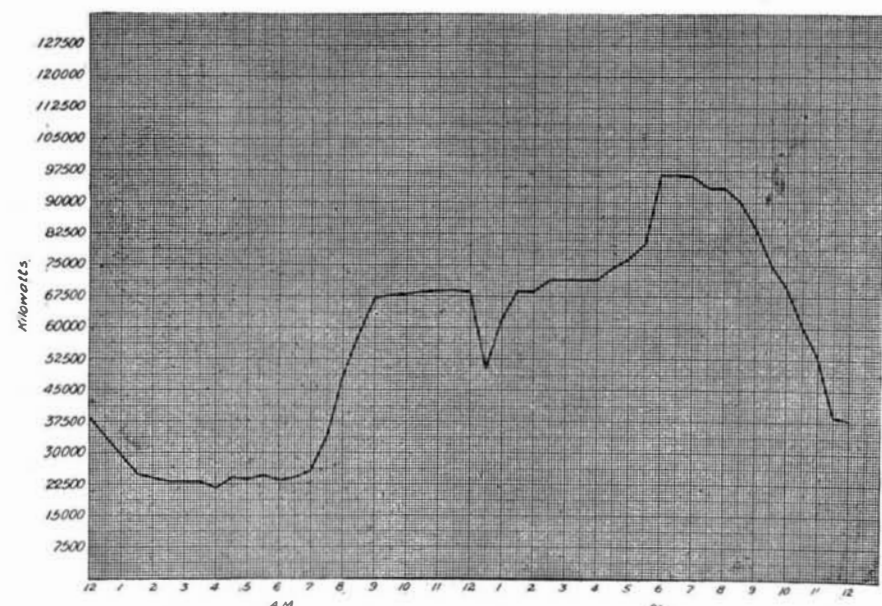


Fig. 3.—A typical load curve of a lighting central station for a normal March day (1911), when the conditions of operation were normal, and the load curve follows a regular daily cycle.

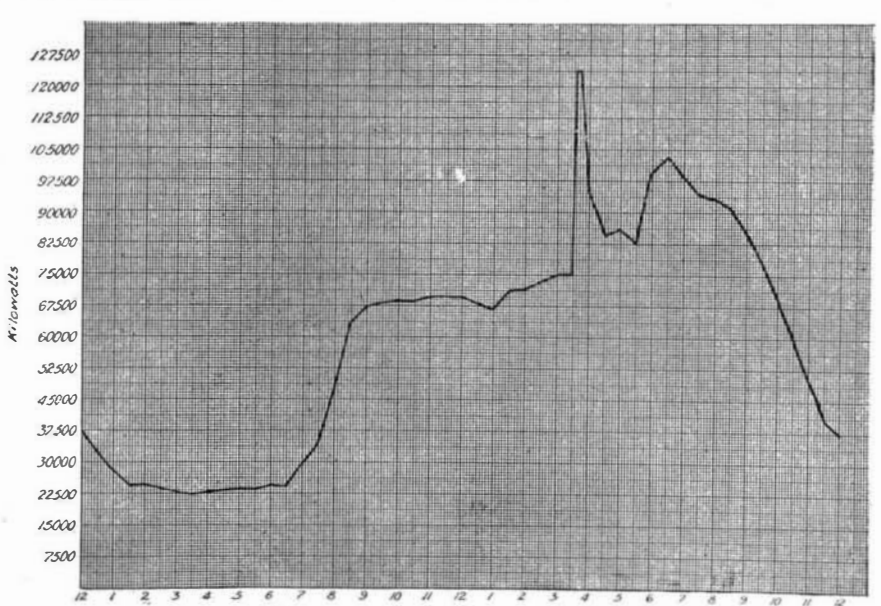


Fig. 4.—An example of a load curve of a lighting central station for a March day (1911), during which a severe unexpected storm took place at 3:30 P. M. But for the abnormal peak occurring because of this storm, the curve would be similar to that of Fig. 3.

OPERATION.

The operation of the apparatus comprising the storm detector leaves practically nothing to be desired. The manner in which it enters into the activities of a steam station will be described, as it is perhaps to such a station that it is of the most benefit.

It will be remembered that the bell or decoherer, together with the coherer and relay, are located in the system operator's office.

It is the duty of the system operator that he keep continuously posted on the demands that are or may be made upon the station for power and to so direct the disposal of all the generating machinery that the station will afford the highest quality of service and will operate with the maximum degree of economy. In detail, the latter function he performs by orders to the boiler room specifying how many boilers shall be maintained under load and how many shall be carried "banked," by instructions to the generating room as to which machines shall be held idle or in readiness, and by orders to the various switchboard operators as to which feeders shall be used in the disposition of the output.

Under the usual daily conditions of operation the demand which will be made upon the station from hour to hour is accurately known, for the variations of the

come over a city with extreme rapidity is much less than that of the slower moving storms, but, on account of their tremendous capacity for suddenly deranging the orderly routine of the lighting station and perhaps even affecting the standard of its service, the fast moving storms make it requisite that all are to be guarded against.

Assume, for instance, such a storm to be approaching a city in which is located a lighting station that possesses a storm detector.

At a time varying from two hours to seven hours before the actual storm clouds reach the city (depending upon whether the path of the storm is a direct or a roundabout one), the alarm bell will begin to strike at intervals of from five to fifteen minutes. The system operator regards this merely as the warning of the possible approach of a storm but gives it no further attention, for the storm may change its direction and pass off without molesting the quiet weather conditions of the city.

The disturbing conditions by their further approach cause the bell to ring oftener. With the storm but about two hours' travel away, the bell will strike about once every half minute or every minute. When this occurs the system operator orders the reserve boilers into service, the auxiliaries of such generating units as he deems may be required started, and the generating units themselves run at low speed.

ing stations would seem to be in the larger cities, particularly in those which possess crowded office districts, as it is the load derived from such a source that is most sensitive to changes in daylight.

A field in which it would also seem that the device would furnish valuable service is that of keeping the isolated hydro-electric station informed as to the weather conditions existing in the distant cities which it is supplying with lighting current. The places of generation and consumption being so far separated, a visual observance of the weather conditions at the power plant would be of no use. By means of storm detectors located in a few of the widely separated towns which receive lighting current from the station, the attendants may keep forewarned by a bell in their station as to the irregular demands which may be made on them by storm clouds passing over those distant towns.

The Antiquity of Some Common Articles of Apparel

THERE is nothing new under the sun; not even a collar stud. It may be rather surprising to the reader that the Romans possessed collar studs, for whoever saw a Roman wearing a collar? The fact is, he did not use the stud to fasten his collar, but perhaps to hold

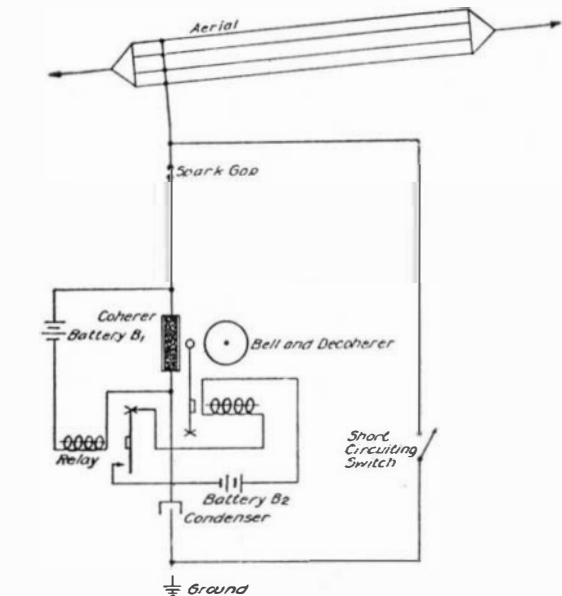


Fig. 5.—Complete diagram of connections of the apparatus comprising "the storm detector."

load curve constitute a daily cycle. These regular changes of load, being anticipated and taken care of by orders from the system operator, become a matter of station routine.

In order to secure smoothness of plant operation, the system operator is informed of the unusual departures from the regular load curve that are to be expected, e. g., exhibition lighting, etc., and also of the weather forecasts. All such is of great assistance in aiding good management. Those unusual irregularities of whose coming he is reliably warned present no difficulties. It has been found by operating experience, however, that the weather forecasts come far from providing a reliable and early warning. Further, the reports are not couched in such terms as furnish the system operator with the information that is of paramount importance to him, viz., the rapidity, in hours, of the approach of the storm.

It is true that the number of severe storms which

These conditions prevail until that later time when the bell gives an insistent warning by uniting its periodic strokes into a continuous ringing. This will ordinarily occur at about one half hour to one hour before the storm reaches the city. It has been found quite often that even at this time the sky will remain clear and unclouded to the eye, which shows how much superior are the services of a storm detector to those of a watchman stationed upon the roof to observe the conditions prevailing in the sky. (This latter practice was the best one available prior to the development of the storm detector.) The switch short-circuiting the detector is closed when the bell begins to ring continuously to protect the receiving apparatus, for the storm will now be comparatively close, and to silence the bell, for its warnings are no longer needed, since it is positively known by this time that the coming of the storm is a certainty. Simultaneous with this action goes the order to synchronize the incoming generating units with the bus. Everything is now in readiness to supply the increased load which will be demanded in but a matter of minutes.

The following are actual records of the frequency of the bell warnings and the loads existing at various times preceding two storms last year.

July 28.

1:45 P. M. 1 bell.

2:15-3:30 P. M. 1 bell every ½ to 1 minute.

3:30 P. M. bell began ringing continuously, load 96,000 kilowatts.

4:15 P. M. (very dark, heavy rain storm), load 142,500 kilowatts.

August 1.

8:25 A. M.-2:00 P. M. 1 bell every 3 to 5 minutes.

2:02 P. M.-2:15 P. M. 1 bell every ½ minute, load at 2:00 P. M., 100,000 kilowatts (cloudy).

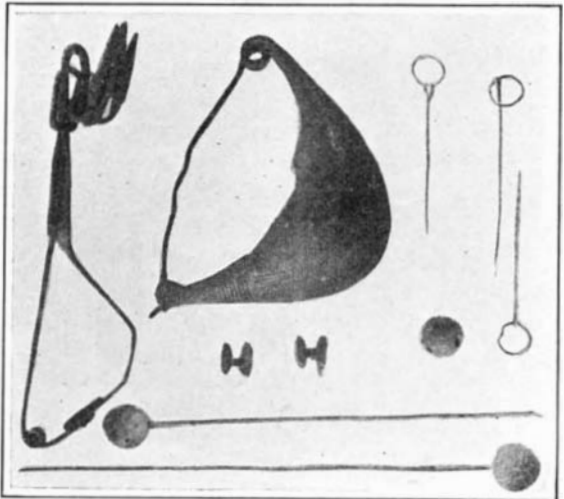
2:15 P. M.-3:20 P. M. bell ringing continuously.

3:45 P. M. load 150,000 kilowatts.

APPLICATION OF THE DETECTOR.

The storm detector as described is in service and located in the office of the system operator in the water-side stations of the New York Edison Company. These stations, so far as it is known, are the only ones possessing a device of the same nature.

The field for such a device among steam-driven light-



Safety pins, clasps, "collar studs" and hair pins of Roman antiquity.

together other garments, and, incidentally, he also applied it to an entirely different purpose, namely, as a caster for chair legs, etc., somewhat after the manner of an article known on the market to-day as "domes of silence." Other articles which have been found among Roman relics are various forms of safety pins, and some hair pins fashioned like the hat pins of to-day. There were also clasps in use which seem to have served to fasten a bouquet to the Roman ladies' dresses.

For Shunting Purposes: at the Cleveland ore docks, with a view to avoiding the inclusion of the shunting engine among the cars being shunted, the Pennsylvania Railway has introduced locomotives which have the peculiarity that they do not run on the same lines as the cars they handle, but on a narrow gage parallel line. Each engine has an arm on each side which can be lowered by means of compressed air controlled from the cab, and acts as a pusher. The locomotives are of Baldwin-Westinghouse make, and are 25 tons in weight. Power is obtained from two rails lying inside the rails on which the locomotives operate; these rails are protected by a wood covering.