this connection vigilance is called for on the part of the Electrical Association.

The papers provided were selected with a view to furnishing information of service to the average central station man. They were all very much appreciated, and the discussions were at times quite animated.

The first paper of the convention was read by M. A. Sammett, of the Montreal Light, Heat and Power Co., and dealt with the Operation of Transformers at Varying Frequencies and Voltages. Mr. Sammett's paper dealt with the iron losses in reducing frequency, those losses being hysteresis and eddy currents. Formulas were given for finding each of these, and comparisons were made between these two losses. It was shown that while eddy current loss remains the same for all frequencies, a decrease in frequency will result in an increase in hysteresis, and consequently a higher temperature of the transformer iron. This temperature rise will cut down the current-carrying capacity of the transformer, and what would under normal conditions be called a normal load would with a lower frequency be an overload, and may cause the burning out of the transformer. The author showed that with an increase of 20 per cent. above normal voltage, hysteresis will increase 34 per cent., eddy current will increase 44 per cent., and the combined loss will increase 37.8 per cent. A change of 10 per cent. above the voltage for which the transformers are designed will allow satisfactory operation and increase the total loss by 0.8 per cent., affecting the result as to the efficiency of either the transformers or the plant but very slightly, while a higher change in voltage will affect the efficiency of the apparatus as well as its rating to a considerable degree. A lowering of 10 per cent. will result in an increased all-day efficiency, as well as cause the transformer to run hotter.

Prof. Herdt, of McGill University, in discussing the paper, stated that some recent experiments show that the eddy current does not vary just as the square of the thickness of the lamination. In very thin laminations it does so, but with thicker laminations it is not as the square, this being probably due to induction in the plates themselves. Tests have also shown that at a temperature of 50 deg. Cent. the eddy current loss would be diminished by half. The pressure on the laminations also affects the eddy current; if the pressure is raised, the eddy current loss is increased.

R. T. McKeen, of the Canadian General Electric Co., read a paper on "Transformers," in which he sketched the history of the transformer and the evolution of the standard types. The paper was freely illustrated by means of the lantern. The early transformers were all of the shell type, and this type held the field until 1896. In that year the core type was developed, and now both types are before the public. About 1896 transformers were developed for use with oil as an insulating and cooling agent. The oil preserves insulating fabrics by keeping them soft and by excluding air and moisture. It also assists in preventing breakdown of insulation, due to minute puncturing by momentary excessive potentials. The magnetic characteristics of iron have been investigated with the result that core losses in transformers have been reduced very greatly, the average core loss per kilowatt in sizes up to 2,500 watts being reduced from 163 in 1889 to 28 in 1905. Several slides were shown illustrating the study of microscopic metallography, by which it has been found that the proportion and distribution of the various components in iron or steel bear a definite relation to its physical and magnetic properties. The characteristics of insulating materials is a subject which has been less studied than any other field connected with transformers. Moisture is the bugbear of the transformer designer, and to prevent the entrance of moisture to the windings, and to remove what may have got in during manufacture several methods have been devised. Mr. McKeen combatted the idea that low core loss is the chief consideration in choosing a transformer, as all types are now very similar in that regard, while possessing wide differences in other respects. The ageing of iron does not, in Mr. McKeen's opinion, receive the attention it deserves, when it is considered that in inferior types of transformers the core loss may increase 10, 20, 30, or in some cases even 100 per cent. from this cause. The question of ageing has been investigated, and, though the cause of it has not yet been determined, it has been found that this increase of loss is dependent upon the temperature at which the iron is maintained. There is a great difference in the ageing of different qualities of iron and steel; soft sheet steel being much less subject to ageing than soft sheet iron. The tendency to age is greater the greater the temperature, but a sheet steel can be obtained which does not age materially at moderate temperatures (below 75 deg. Cent.). This is now used by the large manufacturers, and the transformers so designed as to take the best advantage of its non-ageing qualities.

After this paper, A. A. Wright opened a discussion on the use of oil in transformers, and the following points were brought out: When oil becomes carbonized and thickened it loses its cooling properties, owing to the absence of flow. Whether it loses or increases its dielectric property when carbonized was a point on which there was a difference of opinion. Unless it becomes quite thick there is no great objection to its use. Oil for use in transformers should possess certain characteristics: it should have a low flashing point; it should be absolutely neutral as to acidity and alkalinity; it should be neither too thin nor too thick; it should be capable of withstanding very low temperatures without becoming thick; all moisture should be absolutely excluded—1-10 per cent. moisture in oil reduces its dielectric strength nearly 50 per cent.

William Bradshaw, of the Westinghouse Electric and Manufacturing Co., Pittsburg, read a paper on the "Selection and Maintenance of Service Meters," in which he dealt with the mechanical and electrical characteristics of meters, and their testing. The bearing of a meter, which is the strategic point, can best be constructed by the use of a steel ball between the jewelled surfaces. The torque, or driving force of the meter should be as large as it is possible to obtain with a minimum weight of moving element. To make the effect of friction as slight as possible, the ratio of the torque necessary to overcome friction and the driving torque should be a maximum. Service meters have an inherent tendency to run slow after considerable use, and consequently should have periodic inspection and test. The most accurate method of test is by the use of a special standard integrating watt meter, this being the secondary standard, while the primary standard is kept at the central station. An operating company equipped with a good, reliable and accurate standard and several of the integrating test meters can maintain cheaply and accurately a large number of service meters, and increase its revenue by a considerable percentage. Mr. Bradshaw closed his paper with an outline of a convenient system of recording both line and laboratory tests of service meters.

In the discussion which followed the reading of this paper, Ormond Higman, Chief Electrical Engineer of the Inland Revenue Department, told how the Department tests meters. The meter is tested for starting current at 2 per cent. of its full load capacity. For accuracy they start at quarter load and go up through half and three-quarter to full load and down again. There is also a test for external magnetism. Tests are also made for frequency, variation in wave form, friction, resistance, drop of series coil, consumption of energy, and a temperature test. Mr. Higman would like to see a durability test but in the majority of cases this is impracticable.

A. B. Lambe, of the Canadian General Electric Co., held the attention of his audience thoroughly while he gave an enthusiastic and highly interesting talk on incandescent lamps. With charts of illumination and specimens of lamps, good, bad, and indifferent, as well as specimens to show the process of manufacture of a lamp, he illustrated his talk in a most practical way. Mr. Lambe explained the units used in measurement of light, the unit of light, or candle power, the unit of illumination, or candle foot, and the unit of intrinsic brightness. He then explained the methods