

ing of the same; as at Detroit, where a considerably greater capacity was obtained with an actual reduction both in the amount of line material and in the transformer capacity. Likewise, static transformers have grown in favor as boosters, affording substitutes for the additional wire otherwise required to overcome the line drop. So, also, the systematic testing of line insulators, as inaugurated by the Pacific Light & Power Corporation, and the use of meggers for testing supplies of transformer oils, deserve mention as means for reducing transmission losses.

#### OTHER CENTRAL-STATION TENDENCIES.

One of the noteworthy trends during the past year has been that towards interconnecting generating plants, both for the sake of effecting operating economies and for enabling any of the interconnected stations to take care of abnormal demands. In some instances, as in the case of the Philadelphia Electric Company, this has meant the interconnecting of its own plants in the rapidly developing manufacturing district between Philadelphia and Chester. In other cases it has implied the interconnecting of plants differing as to generating capacity and load-factors. For the latter purpose the plants at Salem, Malden and Revere (all in Massachusetts) were suitably interconnected by tie lines during the past year, thus enabling either the Malden or the Revere plant to be operated more efficiently at certain seasons of the year, and also enabling these plants to sell energy to the Salem company when the demands on the latter exceed its capacity.

Among other practices noted during the past year was that of selling current in bulk to former companies who construct their own transmission lines, as successfully inaugurated by the Wisconsin River Power Company, and the installation of automatic hydroelectric plants as auxiliaries to regularly manned stations, as at Cedar Rapids, Iowa. Also, the placing of service bus wires in conduits run inconspicuously along building fronts in residential districts to relieve both streets and yards of unsightly wiring, while avoiding the expense of underground construction; and the tendency towards discontinuing the gratuitous replacing of incandescent lamps. The urge of economy has also started the adoption of bimonthly billing by some central stations, and the rendering of joint bills for gas and electric light service by companies supplying both services.

#### Electric Transportation Developments.

WHILE disappointment is expressed on many sides at the limited headway made during the past year by electric vehicles, there still has been progress in numerous ways, and with the climbing cost of gasoline, the new year may see more of it. Efforts towards standardizing such vehicles have shown good results, while the handling and interchanging of batteries for auto-trucks has been standardized and expedited. Vacuum-jacketed battery boxes (operating after the manner of so-called thermos bottles) have been introduced for reducing the effect of cold weather on the battery capacity, and central stations have been effectively urged to utilize vehicle battery charging as a means of filling in the valleys of their load curves. In Chicago a guaranteed electric-truck service has been inaugurated by the central-station company.

Perhaps the most notable use of electric vehicles during the year has been in the form of tractors for hauling trucks or cars in munition factories and at freight depots, in which latter connection they have

proven admirable aids towards relieving the congestion which has so seriously handicapped the railroads during the past season. Electric vehicles have also been introduced both in this country and abroad in the form of coal trucks, while storage-battery locomotives have been extensively adopted by the Calumet & Hecla Mining Company for underground rock hauling.

#### URBAN AND INTERURBAN LINES.

As the use of automobiles had not yet been curtailed during 1917 by any war measures, interurban lines have still felt the loss of the local passenger traffic which was diverted from them some years ago. In view of this, and of the effect of the war in reducing the number of employees, there has been a growing introduction of one-man cars, which were installed with very little complaint and with a decided curtailing of operating expenses at Spokane, for instance. Lighter-weight motors have been developed for use on the one-man cars, which are built of considerably lower weight than the older types of the same seating capacity. As another means of overcoming the dearth of skilled labor, the American Electric Railway Association urged apprentice courses.

Electric freight hauling received considerable impetus from the railway congestion of the past year, and some street railways (as, for example, in Massachusetts) profited by the opportunity, while Mr. Doherty urged the night hauling of freight as a means of increasing revenues. Mergers of street-car systems have continued to be numerous, longer-range electric light signals have been developed, and portable electric welders were introduced for use in bonding rails. Considerable attention was paid during the year to car ventilation, extensive tests being made as to the air conditions in street cars operated both with and without special ventilating appliances.

#### RAILROAD ELECTRIFICATION.

In February, the Chicago, Milwaukee & St. Paul Railroad (the first railway in this country to appreciate and utilize the advertising value accruing from electrification) took the last steam-operated train off its Missoula division, and in May the same railway began electrifying another division, comprising 217 miles, for which power is to be furnished through eight substations by the Intermountain Power Company. The Great Northern Railway began construction of a dam at the foot of Lake Chelan and of a power station on the Chelan River, as also of the pole lines for transmitting 150,000 horsepower to operate the company's lines from Spokane to Seattle.

The Lehigh Valley Railroad had its engineering department investigate as to the proposed electrifying of its main line (176) miles between Jersey City and Wilkes-Barre, and of another 52-mile division. The Canadian Northern Railway was reported as proceeding with the electrification of its ten-mile entrance into Montreal.

Notable new equipment ordered during the year included new passenger locomotives for the New York, New Haven & Hartford Railroad, for use interchangeably on an 11,000-volt trolley and on a third-rail portion of the track, each locomotive having 12 motors divided into four groups and arranged for multiple-unit operation. Electric locomotives somewhat similar to those used by the Chicago, Milwaukee & St. Paul Railroad were furnished early in the year by the General Electric Company for the Bethlehem-Chile Iron Mines Company in South America, these being also fitted with regenerative-braking equipment to pro-

vide for adequate control on heavy down grades. On the other hand, the new powerful locomotives designed for the Pennsylvania Railroad are to transform the single-phase trolley current into three-phase energy, thereby utilizing induction motors in which no extra equipment is required for regenerative braking.

#### Electric Power for Industrial Works.

**I**N LOOKING back at the records made in various sections of the country in the electrical equipping of cantonments, munition plants, and other enterprises due to the war, the observer is puzzled as to which to admire most, the alacrity with which the installations were accomplished, or the fine judgment and high engineering skill evidenced by the same. The latter has been particularly noticeable in the equipping of munition plants and other factory buildings, where dependability of service, as well as economy and facility of operation had to be considered. With this in mind, the relative advantages and limitations of group electric drives and of individual motor drives have been studied more extensively than heretofore; as also the advantages of employing several motors instead of a single one for jointly furnishing the power for a given group of machines, thereby enabling a higher motor load-factor to be obtained.

Likewise, the substitution of electric for mechanical driving to increase the output of a factory has shown it to be advisable in many cases to cut the existing shafting into sections and to provide separate motors for each section. Manufacturers of machine tools have co-operated much more extensively than heretofore in properly equipping their products with direct-connected motors, so that the past year's activity along this line should show a lasting effect on machine-tool practice.

#### GROWING USE OF ELECTRIC LABOR-SAVING DEVICES.

Moreover, a systematic study of the factory requirements in the light of the labor situation has led to the introduction of motor-driven labor-saving appliances to a much larger extent than heretofore, while both magnetic clutches and distant-control starting switches have contributed towards increasing the safety of the installations, and the ability to employ unskilled men or those of lower mental caliber, if necessary.

New electrically operated tools have been devised for expediting many classes of work, as, for example, in the cutting of steel plates in shipyards by an electric arc or the oxy-acetylene flame, where an electric motor automatically moves the cutting tool either in a straight line or in a circle, according to the adjustment of the tool. Magnetic separators have grown in use until they are now employed in 25 different industries, and lifting magnets considerably extended their field of usefulness during 1917.

#### ELECTRIC TELPHERAGE.

Electric telpherage also made decided strides, both at the war fronts and elsewhere. The rapidity with which electrically operated telpherage lines were erected in mountainous districts both by the French and by the Italian engineer corps, and the capacity of such speedily erected equipment for handling munitions furnished long desired object lessons. Likewise, the completion of the telpherage installation near the Nevada boundary in California for handling salt for a distance of more than 13 miles over a mountain range from the Saline Valley, demonstrated the value of telpherage in industrial operations.

#### Progress in Electric Lighting.

**U**NUSUALLY fine accomplishments, both in the high character of the installed lighting equipment and in the alacrity with which it was put into service have also been shown during 1917 in the lighting of new factories for munitions and the like, and more recently in the lighting of cantonments. The same delays in securing duplicate machine tools, which prevailed in the two preceding years, forced the substitution of night shifts for factory extensions, and during the past year both central stations and manufacturers of lighting appliances have profited by this opportunity. Factory lighting has been studied as never before, and good lighting has come to be more generally appreciated both as a means for increasing factory output, as a factor in industrial safety, and as a preventive of spoilage. Moreover, factory lighting has been considered more as to service and operating cost rather than from the initial cost of installing the same.

Store lighting has also shown advances and filtered light has been more extensively and intelligently used, since the high efficiency of the modern incandescent lamps enables the user to afford such losses as are implied by color filtration. Carbon-dioxide lamps have proven effective for color matching, and lighting units suitable for color matching have been offered even in portable types for counter use. Tungsten lamps for use in motion-picture projection have been developed in 30-ampere (25-volt) and 20-ampere (30-volt) sizes, each with an effective life of 100 hours, but suitable only for short-range projection.

#### OUTDOOR LIGHTING.

Flood lighting continued its rapid progress of the preceding year and found new applications as in cantonments, for lighting flags, for lighting pole-line sections to facilitate repairs after dark, and for illuminating statues in parks. Flood-light projectors were also used largely in connection with the protective lighting of industrial plants, public utility plants, government works and other establishments likely to tempt the ire of treasonable aliens. Reports as to many of these protective-lighting installations show a systematic planning, with due consideration for the shading of the lamps in one direction, and with the deliberate employment of glare in other directions as an aid in confounding trespassers.

In street lighting, more attention was also paid to glare, silhouette effects and reflection effects as bearing on the service. Tungsten lamps continue to replace arc lamps, and the tendency toward a higher mounting of the lamps has also continued. The prospects of curtailing street lighting to save coal have brought the recommendation that the lighting be continued only from one side of the street, as an alternative to the crime-stimulating complete darkening of the streets on certain nights. The curtailing of sign-lighting hours and the promulgation of Sundays and Thursdays of each week as "lightless" nights have already affected the revenues of central stations, but the threatened "daylight saving" plan has not yet been adopted in this country. If adopted in 1918, it may offset partly the increase in loads due to the night shifts in manufacturing plants.

#### Electric Cooking and Heating.

**O**NE of the features of the year was a decided progress in the widespread introduction of electric ranges. Central stations have wisely catered to